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QUALITY ASSURANCE PROJECT PLAN SUPPLEMENTAL FIELD SAMPLING PLAN AND  
HEALTH AND SAFETY PLAN SITE 22 BUILDING 105 OLD DRY CLEANING FACILITY  
REMEDIAL INVESTIGATION AND RISK ASSESSMENT APENDIX IX NS GREAT LAKES IL  
4/1/2003  
TETRA TECH

# **Quality Assurance Project Plan, Supplemental Field Sampling Plan, and Health and Safety Plan**

**Site 22 - Building 105  
Old Dry Cleaning Facility**

**Remedial Investigation &  
Risk Assessment**

**Appendix IX**

**Naval Training Center Great Lakes  
Great Lakes, Illinois**



**Southern Division  
Naval Facilities Engineering Command**

**Contract Number N62467-94-D-0888**

**Contract Task Order 0290**

April 2003



**TETRA TECH NUS, INC.**

**QUALITY ASSURANCE PROJECT PLAN,  
SUPPLEMENTAL FIELD SAMPLING PLAN,  
AND HEALTH AND SAFETY PLAN  
SITE 22 – BUILDING 105  
OLD DRY CLEANING FACILITY**

**REMEDIAL INVESTIGATION & RISK ASSESSMENT**

**NAVAL TRAINING CENTER GREAT LAKES  
GREAT LAKES, ILLINOIS**

**COMPREHENSIVE LONG-TERM  
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT**

**Submitted to:  
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Naval Facilities Engineering Command  
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**CONTRACT NUMBER N62467-94-D-0888  
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**APRIL 2003**

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## **PREFACE**

This Quality Assurance Project Plan (QAPP) Appendix IX has been prepared by Tetra Tech NUS (TtNUS), on behalf of the United States (U.S.) Navy Southern Division Naval Facilities Engineering Command and Naval Training Center (NTC) Great Lakes, Great Lakes, Illinois under the Comprehensive Long-term Environmental Action Navy (CLEAN) III Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0290.

The investigation at Site 22 – Building 105 Old Dry Cleaner Facility will be similar to the investigation at Site 7. This QAPP Appendix IX is intended to be used in conjunction with the project-specific Field Sampling Plan (FSP) and Health and Safety Plan (HASP) submitted herewith, as well as the existing QAPP for Site 7 – RTC Silk Screen Shop and Site 17 – Pettibone Creek & Boat Basin, Remedial Investigation & Risk Assessment, the project planning document for NTC Great Lakes (TtNUS, 2001).

This QAPP Appendix IX and the existing QAPP present the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the Site 22 - Building 105 Old Dry Cleaning Facility at NTC Great Lakes. Specific protocols for sampling, sample handling and storage, chain of custody, and laboratory and field analyses are described.

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## **A. PROJECT MANAGEMENT**

This section is an addendum to Section A of the existing Quality Assurance Project Plan (QAPP), Site 7 – RTC Silk Screen Shop and Site 17 Pettibone Creek & Boat Basin for Naval Training Center (NTC) Great Lakes (TtNUS, 2001). The investigation at Site 22 – Building 105 Old Dry Cleaner Facility will be similar to the investigation at Site 7. Changes to the existing QAPP that are specific to the investigation at Site 22 – Building 105 Old Dry Cleaning Facility are provided below.

### **A5.A.4 Site 22 - Building 105 Old Dry Cleaning Facility**

Site 22 - Building 105 Old Dry Cleaner Facility is located at the NTC Great Lakes, Lake County, Illinois. Site 22 is bounded on the south by Porter Street, on the west by a vacant asphalt paved lot, on the north by Bronson Avenue, and on the east by Sampson Street (see Figure A-19). NTC Great Lakes (U.S. EPA # IL7170024577) has operated with Resource Conservation and Recovery Act (RCRA) interim status authorization since November 19, 1980. Building 105 was originally included in a RCRA Part A permit that has been modified over the past 25 years. The RCRA unit is located in the SE quarter of the NW quarter of the SW quarter of Section 4, Township 44 North, Range 12 East. A RCRA Closure Plan specific to Building 105 was submitted to Illinois Environmental Protection Agency (IEPA) on May 16, 2001. IEPA approved the RCRA Closure Plan for Building 105 in a letter dated June 29, 2001.

Building 105 was constructed in 1939 and was utilized as a dry cleaning facility until 1993 or 1994 when it was converted to a vending machine supply and repair station. The building consists of a slab-on-grade building measuring approximately 150 feet by 70 feet. The 10,500-square foot building occupied a lot approximately 250 feet by 115 feet. From 1993 or 1994 until February 2001, the building was used to warehouse and repair vending equipment and products. The vending machine supply and repair operations ceased in February 2001, and the building was vacant until it was demolished in March 2003.

The RCRA unit (SO1) in Building 105 consisted of a drum storage area located inside along the east wall. Hazardous waste consisting of spent tetrachloroethene (PCE) from the laundry facilities was stored in this area from 1980 until 1987. The maximum quantity of waste stored at this unit is unknown; however according to the revised RCRA permit, 165 gallons (three 55-gallon drums) was the maximum amount of waste stored at one time in this area. The storage area consisted of the concrete floor (no berms or curbs were present) of the building adjoining the concrete block exterior wall. Near the storage area, two cracks and construction joints in the concrete floor, a garage-type entry door, and several floor drains were observed. Historic building foundation plans show the floor drains were connected to the storm

water system located outside of the building. No visual evidence of spillage (no staining) was observed or reported in this area, and the floor was in good condition.

The building foundation plans also show two 6-inch drains from the gutter under the washing machines associated with previous laundry operations. These drains were connected to a grease catch basin located outside the southeastern corner of the building by a 6-inch cast iron pipe. The grease catch basin was approximately 5 feet by 7.5 feet by 5.5 feet deep with two chambers and had a 6-inch tile effluent pipe that was connected to another catch basin.

Previous investigations at Building 105 resulted in correspondence with the IEPA, the implementing agency for unit closure. Soil and groundwater sampling (locations shown on Figure A-20) was conducted at Building 105 as documented in the Partial Closure Certification and Sampling/Inspection Report (PCC&SIR) (Earth Tech, 1998). According to the PCC&SIR, the chemicals of concern (COCs) are PCE and cis-1,2-dichloroethene (DCE) in soil and PCE and DCE in groundwater.

#### Previously Documented Soil Contamination

Shallow soil samples were collected from 0 to 12 inches below grade in 1993. Twenty-four additional soil samples were collected between 1995 and 1998, to a maximum depth of 6 feet. At sample point GL95-105S-134, the vertical extent of the soil plume was determined to be 72 inches deep or the top of the saturated zone. Contaminated soil samples in the saturated zone, greater than approximately 72 inches below ground surface (bgs), are considered by IEPA to be a groundwater issue. In 2001, additional core samples were examined for ionizable vapor concentrations utilizing a photoionization detector (PID), and samples were collected for analysis at both the former hot spots and other locations where PID readings exceeded background in the vadose zone. Most of these soil samples were collected from 8 to 12 feet bgs. Maximum contaminant levels detected for soil samples from these investigations were as follows:

- PCE at 1,500,000 ug/kg at GL95-105S-1: 30 to 36 inches deep
- DCE at 820 ug/kg at GL98-105S-1 and TOL01-GP04: 9.5 to 10 inches deep
- Acetone at 43,000 ug/kg at GL95-105s-12: 0 to 6 inches deep
- Trichloroethene (TCE) at 7 ug/kg at GL93-105S-2: assumed collected at the surface

Table A-18 provides a summary of the results of previous soil sampling and Figures A-21 to A-24 show exceedances of IEPA Tiered Approach to Corrective Action Objectives (TACO) soil criteria at depths of 0 to 1 foot, 3 feet, 4 to 8 feet, and 8 to 12 feet, respectively. Concentrations of PCE and cis-1,2-DCE in soil exceeded IEPA TACO Class I soil to groundwater clean up objectives. The concentrations of PCE in soil



also exceeded the IEPA TACO soil ingestion and inhalation exposure route clean up objectives. The acetone detection was considered a lab contamination issue; therefore, acetone was not included on the list of COC. TCE was detected in two locations, but not considered a COC for the following reasons:

- the one location had a TCE concentration of 7 ug/kg in the surface soils (0 to 6 inches bgs); therefore, this contamination would be removed as part of the demolition activities and not considered a pertinent laboratory parameter for the RCRA closure.
- the second location had a TCE concentration of 6 ug/kg in the surface soil (5 to 6 inches bgs). The laboratory report qualifies this TCE result with a "J", which signifies that the result is an estimate. In addition, the detected concentration is within 1 ug/kg of the clean up objective for TCE (5 ug/kg). Based on the shallow occurrence of these detections and the estimated low concentration, TCE was not included as a COC in soil for purposes of RCRA closure at Building 105.

#### Previously Documented Groundwater Contamination

Previous reports indicate that groundwater samples were collected from the shallow groundwater zone, approximately 5 feet below the water table (11 to 15 feet bgs) between 1996 and 2001. The vertical extent of the dense non-aqueous phase liquid (DNAPL) groundwater plume was not determined by previous investigations. Maximum contaminant levels detected for groundwater samples were as follows:

- PCE at 7,400 ug/L at GL96-105G-03
- DCE at 3,200 ug/L at TOL01-GP01

The "hot spot" is apparently located on the southern and eastern sides of the building along Sampson Street. Table A-19 provides a summary of the results of previous groundwater sampling and Figure A-25 show exceedences of IEPA TACO groundwater criteria.

#### **A5.B Project Problem Statement**

Because of operationally related chemical releases detected at Site 22 during the previous investigations, risks to human and ecological receptors could be unacceptable. The risks are expected to be confined primarily to vapors/air, aqueous, and solid media.

Past sampling, although limited in some areas, identified the presence of select contaminants at Site 22. Previous sampling has not been adequate to delineate the extent of contamination. This investigation is designed to further delineate the nature and extent of contamination in groundwater and soil believed to

be related to a Navy source. It is also designed to provide information to implement a baseline human health risk assessment (see Appendix I.3), a screening-level ecological risk assessment, and Step 3A of the baseline ecological risk assessment process (see Appendix II.1). Because of these general objectives, several decision statements have been developed for this project that apply to multiple environmental media. The decision statements that will facilitate attainment of the project objectives for Site 22 are shown on Figures A-6 to A-11.

### **Project Status/Phase**

One round of sampling is expected for this investigation. The need for additional sampling rounds will be determined based on whether the extent of contamination is established within prescribed bounds of the data quality objectives. The strategy for additional sampling rounds will be similar to this initial phase of sampling when establishing extent of contamination.

### **A6.A.2 Project Target Parameters**

A detailed list of target analytes and associated environmental media at Site 22 is presented in Table A-20.

### **A6.A.3 Project Target Matrices**

For Site 22, the matrices to be sampled are groundwater, surface soil, and subsurface soil.

### **A6.A.4 Special Project Target Analytes**

? A detailed list of target analytes and associated environmental matrices specific to Site 22 is presented in Table A-20. No special analytical methods will be used in support of this investigation. In general, the methods selected are standard U.S. EPA methods. The selected methods are suitable for measuring the target analytes in the matrices of interest at the concentration levels of interest.

Some analytical measurements will be made in the field. The field measurements are designed for four basic purposes:

1. To support health and safety functions
2. To provide screening-level information to confirm that groundwater sampling conditions are stable before groundwater samples are collected

3. To direct VOC sampling from soil matrices
4. To provide data for analysis of monitored natural attenuation as a possible remedial action for the groundwater.

None of the field analytical results will be used directly in establishing the nature and extent of contamination or in evaluating risks. Field and laboratory analytical tasks are differentiated and delineated in Section B of this QAPP.

#### **A6.B     Schedule**

The schedule for preparation of the QAPP, implementation of the field work and laboratory analysis, evaluation of the data, and preparation of the remedial investigation/risk assessment (RI/RA) report is shown on Figure A-26. The schedule includes approximately 30 days for regulatory review of the draft QAPP and RI/RA report, as well as time for several meetings to discuss the project. Project delays will be communicated by the TtNUS TOM to the Navy RPM, IEPA PM, and U.S. EPA PM.

**TABLE A-18**  
**SOIL FREQUENCY OF DETECTION**  
**SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY**  
**NTC GREAT LAKES, ILLINOIS**

Parameter	Frequency of Detection	Range of Detections	Average of Detections	Location of Maximum Detection	IEPA TACO Exposure Route-Soil to Groundwater <sup>1</sup>	IEPA TACO Exposure Route-Soil Inhalation <sup>1</sup>	IEPA TACO Exposure Route-Soil Ingestion <sup>1</sup>
<b>VOLATILE ORGANICS (ug/kg)</b>							
1,1-Dichloroethene	1/1	6	6	TOL01-GP01B	60	1500000	700000
cis-1,2-Dichloroethene	5/5	21 - 820	491	GL98-105S-11, TOL01-GP04	400	1200000	780000
Tetrachloroethene	38/38	10 - 1500000	89064	GL95-105S-13	60	11000	12000
trans-1,2-Dichloroethene	1/1	16	16	TOL01-GP01B	700	3100000	1600000
<b>MISCELLANEOUS PARAMETERS (mg/kg)</b>							
Percent Moisture	10/10	13.1 - 25.8	19	TOL01-GP01A	NA	NA	NA
Percent Solids	10/10	74.2 - 86.9	81	TOL01-GP13	NA	NA	NA
Specific Gravity	1/1	2.0201	2	TOL01-GP11	NA	NA	NA
Total Organic Carbon	2/2	13000 - 55000	34000	TOL01-GP01A	NA	NA	NA

NA - Not applicable

<sup>1</sup>Tiered Approach to Corrective Action Objectives (TACO) (IEPA, 1996 revised 2003)

Note: Shaded IEPA TACO criteria are screening values that are less than the maximum detected concentration

Associated Samples:

GL95-105S-101	GL95-105S-21	GL95-105S-71
GL95-105S-103	GL95-105S-23	GL95-105S-81
GL95-105S-11	GL95-105S-31	GL95-105S-83
GL95-105S-113	GL95-105S-33	GL95-105S-91
GL95-105S-121	GL95-105S-41	GL95-105S-93
GL95-105S-123	GL95-105S-43	GL98-105S-11
GL95-105S-124	GL95-105S-51	GL98-105S-12
GL95-105S-13	GL95-105S-53	GL98-105S-13
GL95-105S-131	GL95-105S-61	GL98-105S-14
GL95-105S-133	GL95-105S-63	GL98-105S-15
GL95-105S-134	GL95-105S-64	TOL01-GP01A

**TABLE A-19**  
**GROUNDWATER FREQUENCY OF DETECTION**  
**SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY**  
**NTC GREAT LAKES, ILLINOIS**

Parameter	Frequency of Detection	Range of Detections	Average of Detections	Location of Maximum Detection	IEPA TACO Exposure Route-Groundwater Ingestion <sup>1</sup>
<b>VOLATILE ORGANICS (ug/L)</b>					
1,1-Dichloroethene	1/1	0.6	0.6	TOL01-GP05WG	7
cis-1,2-Dichloroethene	6/6	0.7 - 3200	777	TOL01-GP01WG	70
Tetrachloroethene	9/9	2 - 7400	1617	GL96-105G-03	5
trans-1,2-Dichloroethene	3/3	1 - 35	16	TOL01-GP01WG	100

<sup>1</sup>Tiered Approach to Corrective Action Objectives (TACO) (IEPA, 1996 revised 2003)

Note: Shaded IEPA TACO criteria are screening values that are less than the maximum detected concentration

Associated Samples:

GL98-105G-13WG

TOL01-GP01WG

TOL01-GP02WG

TOL01-GP05WG

TOL01-GP07WG

TOL01-GP08WG

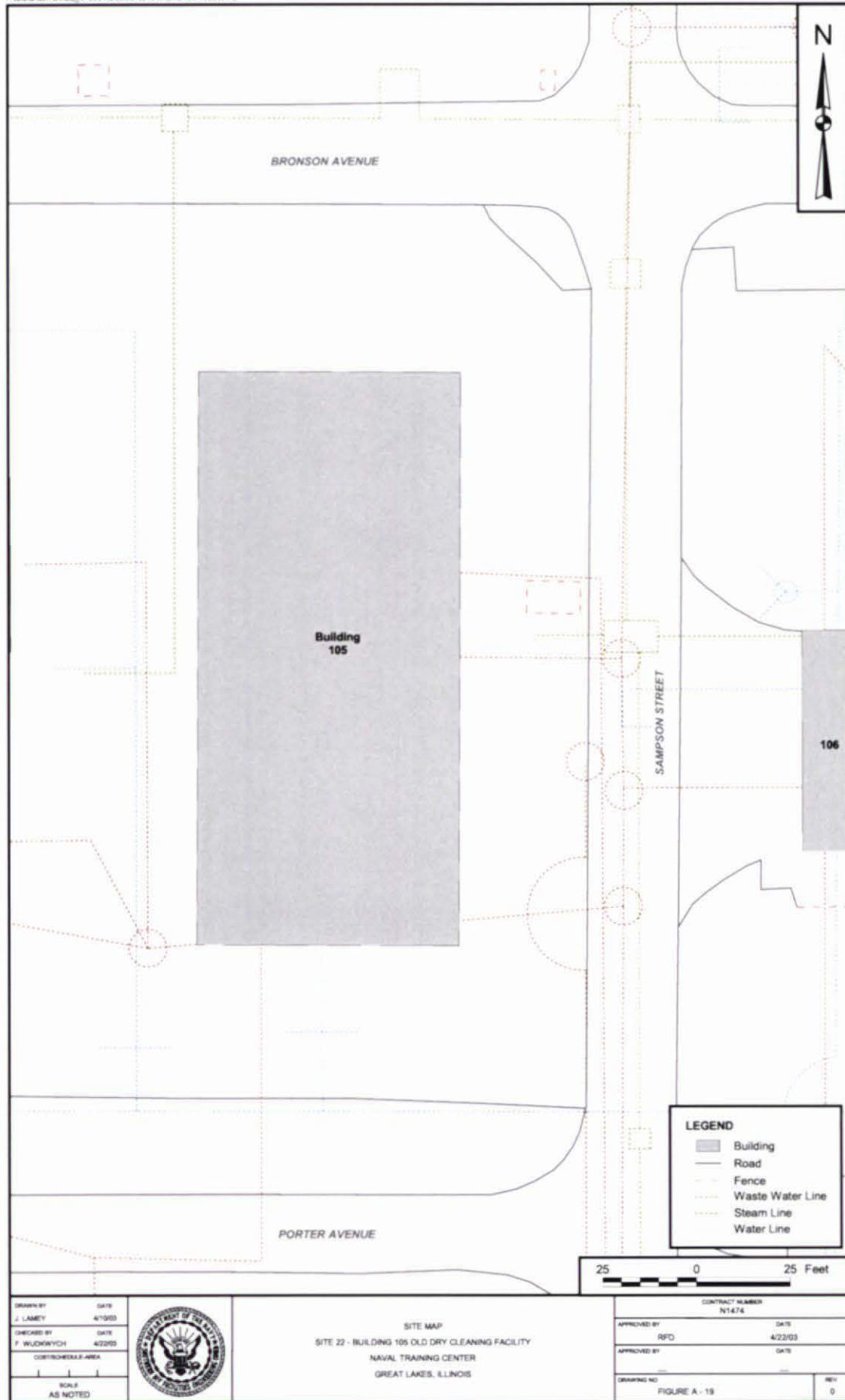
TOL01-GP13WG

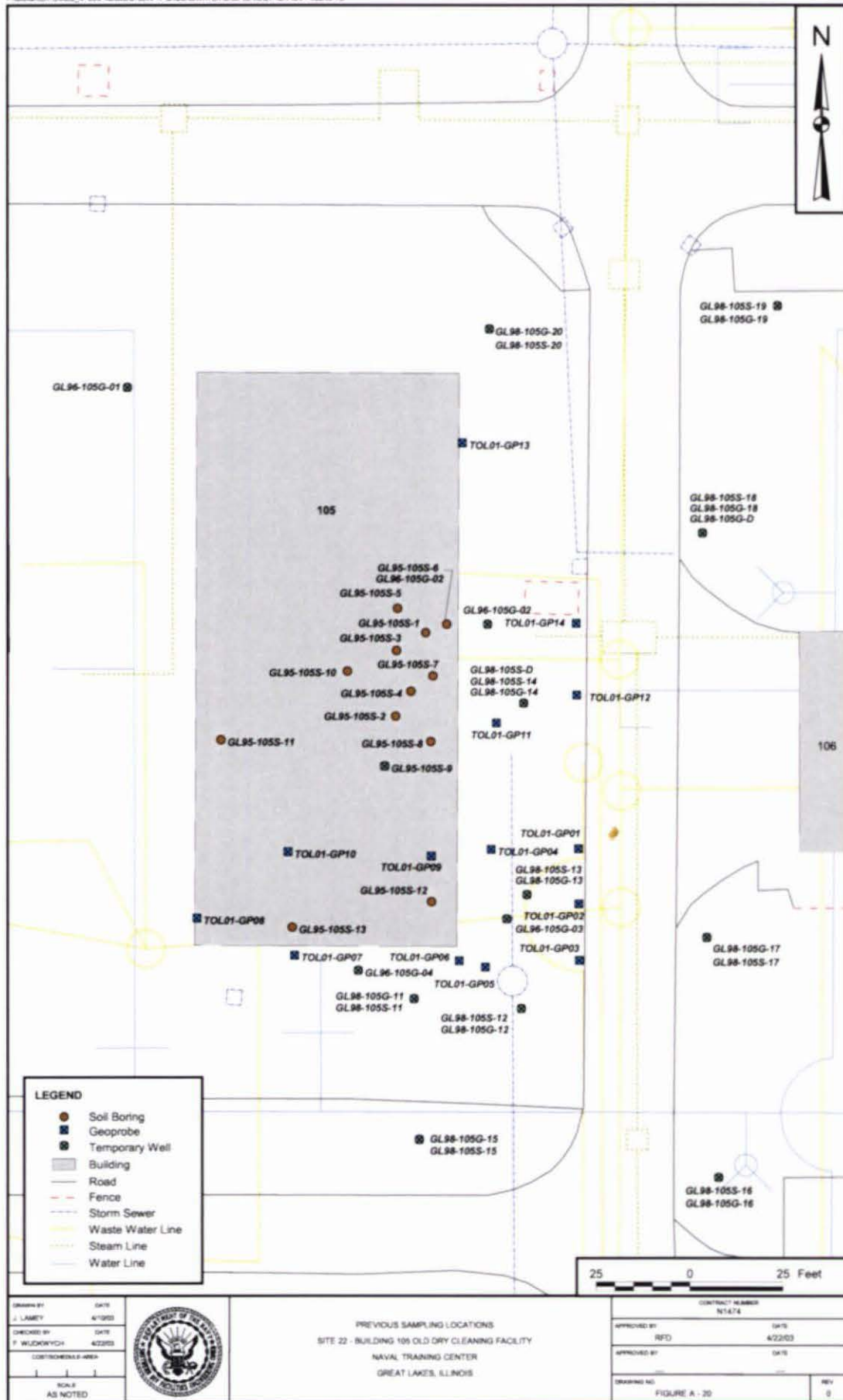
TABLE A-20

PROJECT TARGET PARAMETERS, MATRICES, AND RATIONALES  
SITE 22 – BUILDING 105 OLD DRY CLEANER FACILITY  
NTC GREAT LAKES, ILLINOIS

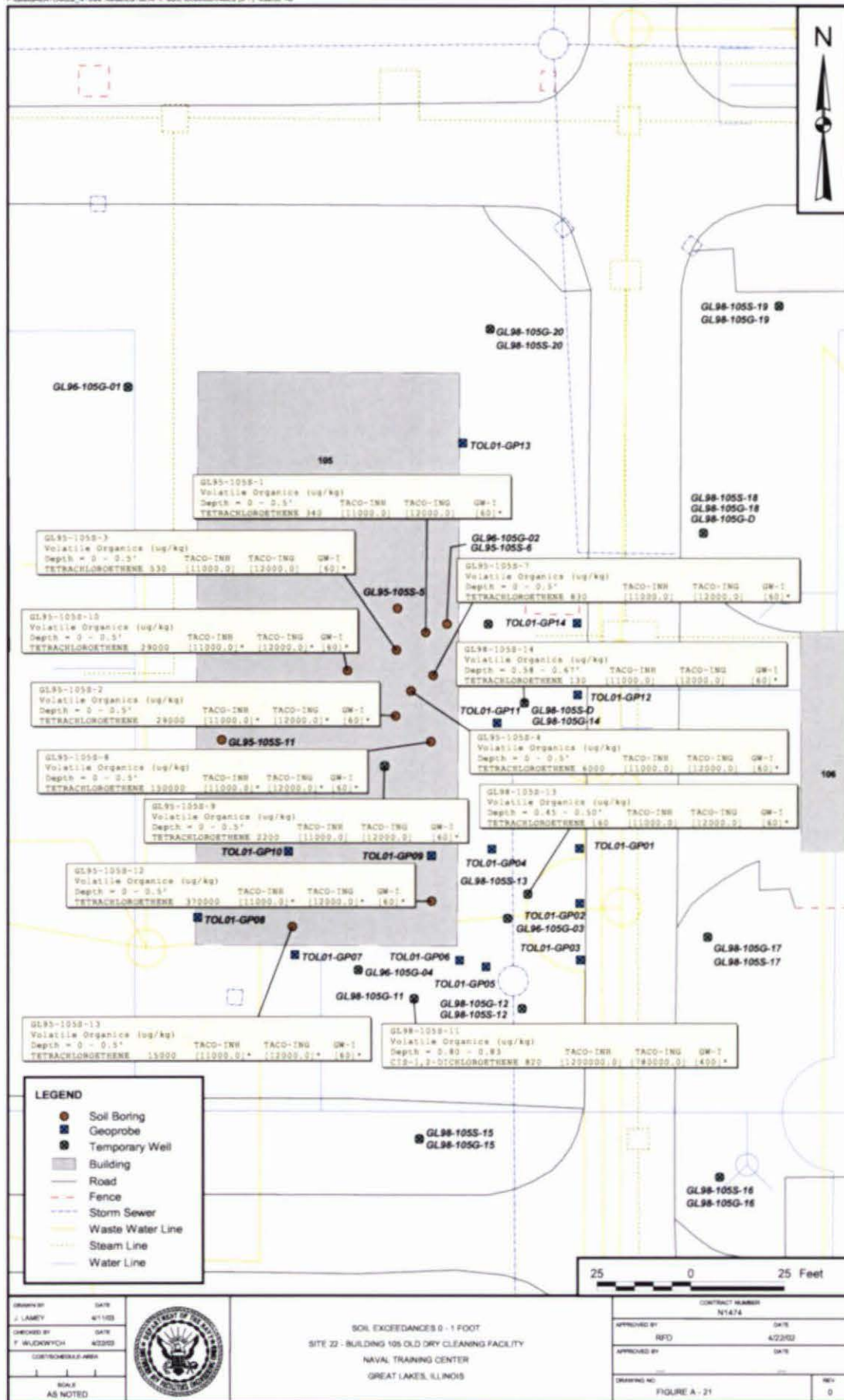
Parameter	Environmental Medium			Intended Data Use
	GW	SS	SB	
Target Compound List (TCL) chlorinated volatile organics (1,1,1-Trichloroethane [TCA], 1,1,1,2-TCA, 1,1,2,2-TCA, 1,1,2-TCA, 1,1-Dichloroethane, 1,2-Dichloroethane, 1,1-DCE, carbon tetrachloride, chloroethane, chloromethane, cis-1,2-DCE, trans-1,2-DCE, PCE, TCE, vinyl chloride)	X	X	X	Delineating the nature and extent of contamination
Methane, ethane, ethane, iron, manganese, alkalinity, sulfate, sulfide, nitrate, nitrite, chloride	X	-	-	Natural attenuation analysis
Dissolved oxygen, carbon dioxide, Manganese, ferrous iron, alkalinity, sulfide, hydrogen sulfide – test kits <sup>(f)</sup>	X	-	-	Natural attenuation analysis
Total organic carbon (TOC)	X	X	X	Organic chemical bioavailability
Toxicity Characteristic Leaching Procedure (TCLP) organics and inorganics	X	X	X	Waste disposal characterization
Grain Size/porosity	-	X	X	Soil physical characterization
pH <sup>(f)</sup>	X	-	-	Aquifer stabilization prior to sampling and natural attenuation analysis
Turbidity <sup>(f)</sup>	X	-	-	Aquifer stabilization prior to sampling
Specific conductance <sup>(f)</sup>	X	-	-	Aquifer stabilization prior to sampling
Dissolved oxygen - meter <sup>(f)</sup>	X	-	-	Aquifer stabilization prior to sampling
Hydraulic conductivity <sup>(f)</sup>	X	-	-	Aquifer characteristics
Temperature <sup>(f)</sup>	X	-	-	Aquifer stabilization prior to sampling and natural attenuation analysis
Oxidation-reduction potential (ORP) <sup>(f)</sup>	X	-	-	Aquifer stabilization prior to sampling and natural attenuation analysis

f Field analysis  
GW – ground water  
SS – surface soil  
SB – subsurface soil

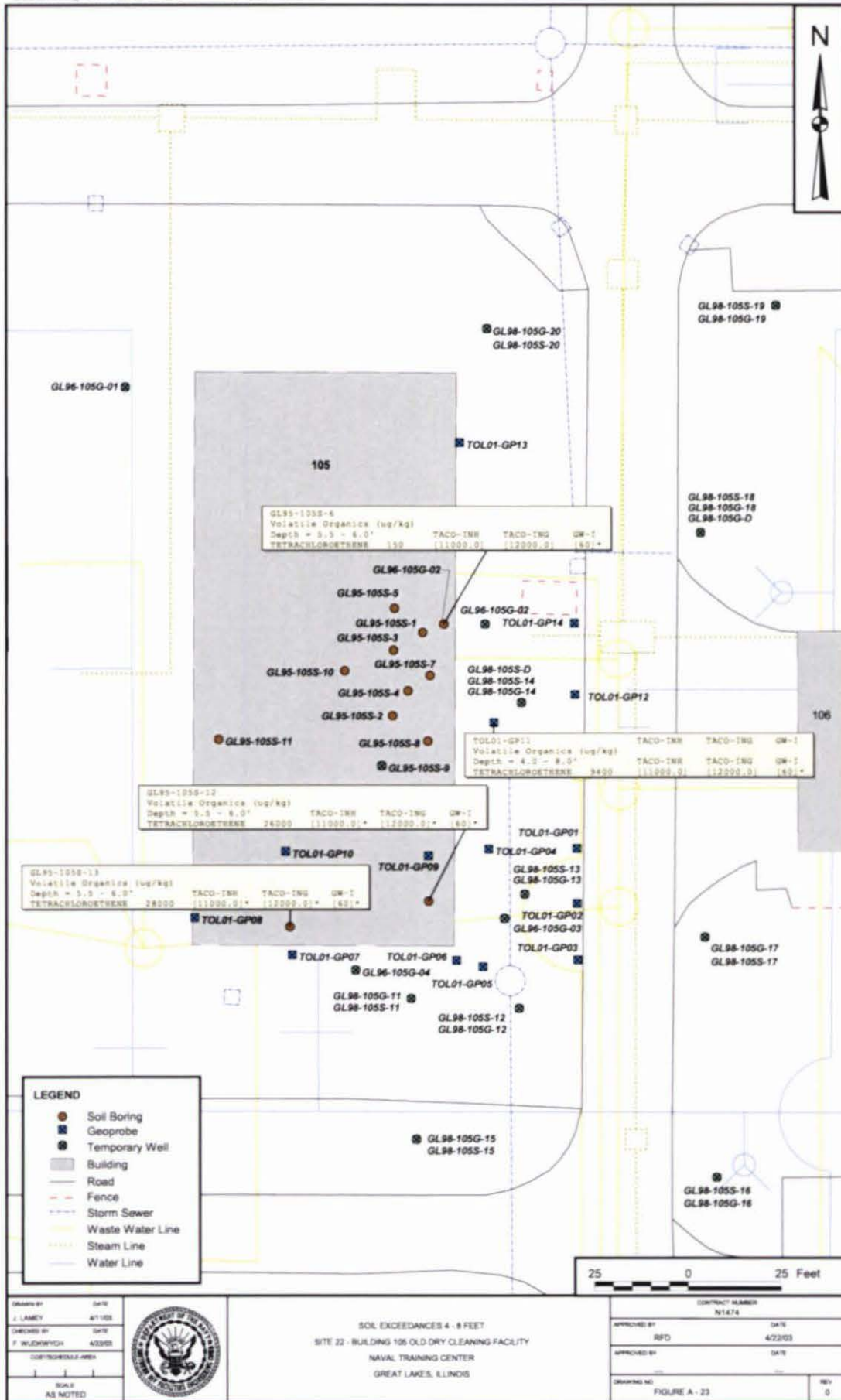




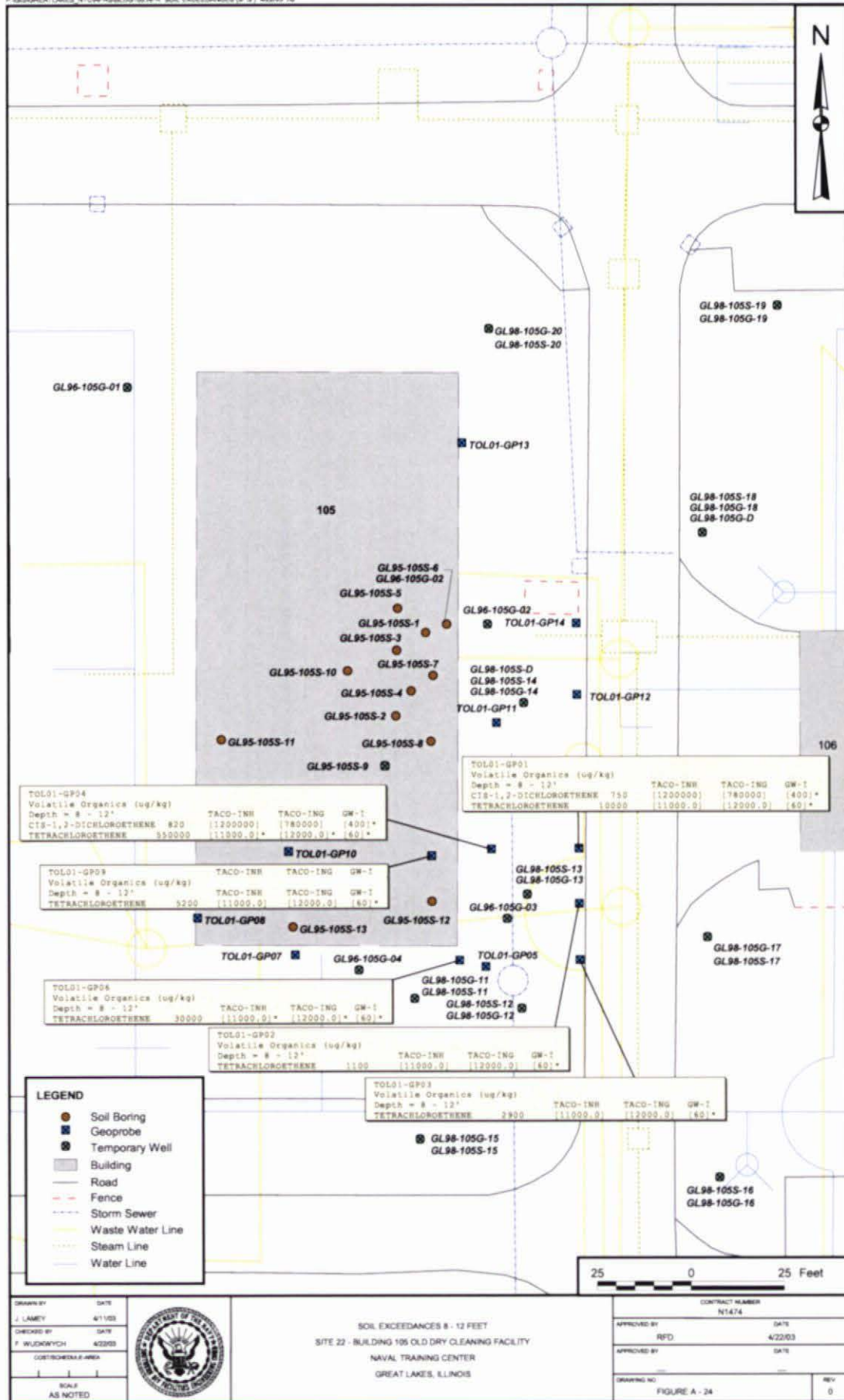








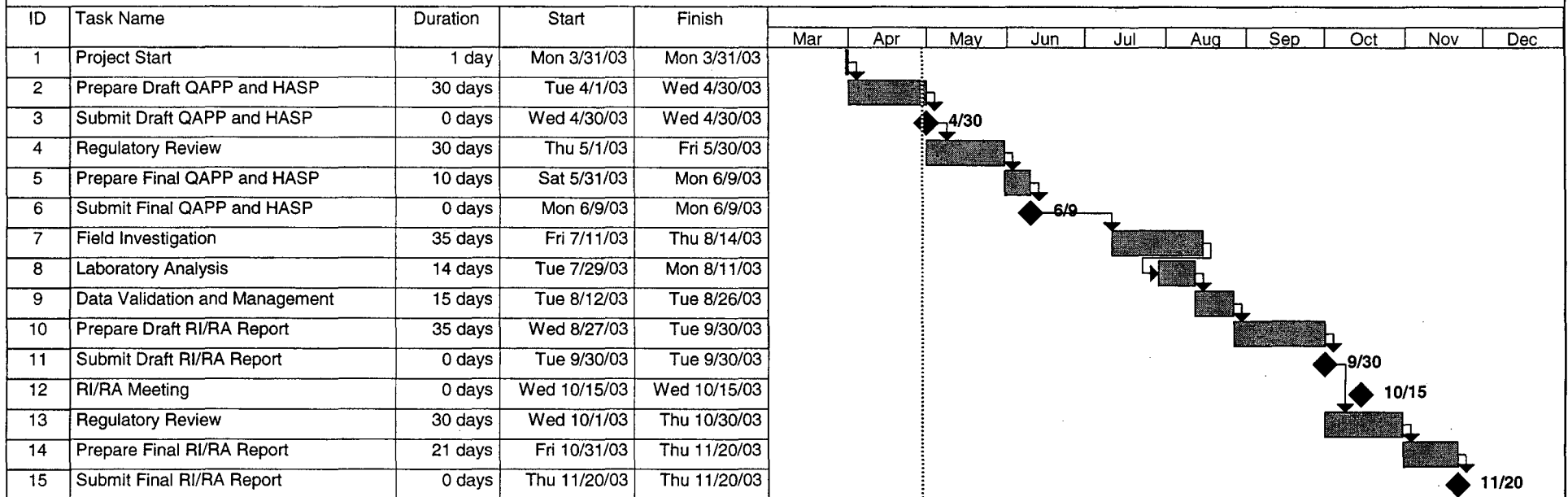






**FIGURE A-26**  
**PROJECT SCHEDULE**  
**SITE 22 - BUILDING 105 OLD DRY CLEANER FACILITY**  
**NTC GREAT LAKES, ILLINOIS**

NTC Great Lakes  
 QAPP Site 22  
 Revision : 0  
 Date: April 2003



Task		Rolled Up Task		Project Summary	
Split		Rolled Up Split		External Milestone	
Progress		Rolled Up Milestone		Deadline	
Milestone		Rolled Up Progress			
Summary		External Tasks			

## **B. DATA GENERATION AND ACQUISITION**

This section is an addendum to Section B of the existing QAPP (TtNUS, 2001) for NTC Great Lakes. The planned investigation at Site 22 – Building 105 Old Dry Cleaner Facility will be similar to the investigation at Site 7. Changes to the existing QAPP are noted in the text below.

### **B1.C Site 22 - Building 105 Old Dry Cleaning Facility**

Site 22 historical sampling indicated that a contaminant release has occurred, and it is likely that the conditions may have changed since the last sampling event. Site conditions related to contaminant release and migration pathways indicate a potential for migration of site contaminants. Groundwater was impacted by the release. A judgmental sampling design was used to maximize the potential for determining the extent of contamination while providing enough data to estimate risks. The risk estimates, because they are generally biased toward contaminated areas, are expected to be elevated relative to the actual human risk at the site. Details of the human health risk scenarios are presented in Appendix I.3 (attached to this appendix).

Soil and groundwater sampling locations are presented in Figures B-4 and B-5, respectively. Soil sampling locations and depths are consistent with the human receptor exposure scenarios and were selected to estimate contaminant concentrations for establishing the nature and extent of contamination and to estimate human health risk for receptors exposed to surface and subsurface soils. The well locations were selected to provide water level data useful for estimating groundwater flow direction, and to provide data on the nature and extent of contamination and risk to human receptors.

### **B2.A.13 Site 22 - Surface and Subsurface Soil Sampling**

This section of the QAPP addendum describes the sampling procedures for the field investigation at Site 22 – Old Dry Cleaning Facility. Additional information is provided in Section B2.A.1 of the existing QAPP. Ten surface and 30 subsurface soil samples will be collected from 9 monitoring well locations and 9 soil boring locations from locations chosen based on visual observation and historical data from Site 22. Two subsurface soil samples will be collected from most of the soil and monitoring well borings.

Surface and subsurface soil samples will be collected using Direct Push Technology (DPT), Hollow Stem Auger (HSA) and split-spoon sampling techniques, a stainless steel hand auger, or single-use, dedicated plastic trowels. Upon sample retrieval, the samples will be monitored with a PID to detect VOCs and then

retained for lithologic and chemical analysis. Samples for chlorinated VOC analysis will be collected with EnCore samplers. Samples for other analysis (i.e. total organic carbon, grain size, etc.) will be collected using a disposable plastic trowel. The samples will immediately be placed in a cooler at 4°Celsius. Before samples are obtained, pertinent ambient conditions and field data will be recorded in the field logbook and on the soil sample log sheet (included in Appendix V). For additional guidance regarding surface soil sampling, refer to Appendix V, SOP CTO 154-6. Tables B-23 and B-24 present summaries of soil samples to be collected at Building 105, including numbers and types of QA/QC samples.

If the soil recovery from the first sample collection attempt produces an inadequate yield to fill sample containers an alternative method will be used to fill the remaining sample containers. The alternative method could be to offset the sample location a foot and resample the interval.

Soil borings will be installed by DPT or HSA methods at Building 105, including:

- The borings will be located at locations shown on Figures B-4 and B-5. Their depths will be to 20 feet bgs with one soil boring to 50 bgs feet for lithologic purposes.
- Soil borings will be converted to monitoring wells after soil samples are collected from the boring. These monitoring wells will be used to determine groundwater quality and flow direction.
- Soil samples will be collected from each soil boring according to the depths described in Table B-23 and as follows:
  - Surface soil samples will be collected immediately below the high density polyethylene (HDPE) liner and gravel located approximately 1 foot bgs.
  - Between 1 foot bgs and the water table, a sample for chlorinated VOC analysis will be collected from the 1 foot interval with the highest PID reading. If no elevated PID readings are observed, the subsurface sample will be collected based on visual observations of staining or non-native soil. If neither of these situations is encountered, the sample will be collected from a randomly selected 1 foot interval (see SOP CTO 154-6).
  - Several borings will also collect a "clean" sample to delineate the vertical limit of contamination.



Surface and subsurface soil samples will be collected from soil borings using DPT 4 foot core samplers or HAS and 2 foot split-spoon samplers, as appropriate. The surface and subsurface soil sampling will be conducted in accordance with SOP CTO 154-6, contained in Appendix V.

Upon sample retrieval, the soil to be analyzed for chlorinated VOCs will be collected first using EnCore samplers and placed in a cooler of ice maintained at 4°C. The soil to be analyzed for other parameters (i.e., TOC, grain size, etc.) will then be mixed, placed into the required containers, immediately sealed, and placed in a cooler at 4°C. The 4 foot-long clear plastic sleeves inside of the DPT samplers will be cleaned of visual soil and disposed of as trash.

Analytical parameters for surface and subsurface soil samples include the following:

- TCL chlorinated VOCs (1,1,1-Trichloroethane [TCA], 1,1,1,2-TCA, 1,1,2,2-TCA, 1,1,2-TCA, 1,1-Dichloroethane, 1,2-Dichloroethane, 1,1-DCE, carbon tetrachloride, chloroethane, chloromethane, cis-1,2-DCE, trans-1,2-DCE, PCE, TCE, vinyl chloride)
- Total organic carbon (TOC)
- Grain size (field observations and laboratory analysis) and porosity

#### **B2.A.15 Site 22 - Monitoring Well Installation**

Refer to Section B2.A.3 of the existing QAPP. The monitoring wells to be installed at Site 22 will be installed as permanent wells.

#### **B2.A.16 Site 22 - Monitoring Well Construction**

Refer to Section B2.A.4 of the existing QAPP. The monitoring wells to be installed at Site 22 will be installed as permanent wells.

#### **B2.A.18 Site 22 - Groundwater Sampling**

Nine groundwater samples will be collected from the nine monitoring wells at locations within, upgradient, downgradient, and cross-gradient of the site. The upgradient well to be installed at the northwestern boundary, will be designated 22MW01S. The cross-gradient well located at the northeastern boundary will be designated 22MW02S, and the five wells in and around the source area will be designated 22MW03S, 22MW04S, 22MW05S, and 22MW06S and 22MW06D. The four downgradient/cross-gradient monitoring wells will be designated 22MW07S, 22MW07D, 22MW08S, and 22MW09S. The groundwater

sampling will be conducted in accordance with the requirements of the project-specific Work Plan and in accordance with SOP CTO 154-3, contained in Appendix V.

Tables B-25, B-26, and B-27 present summaries of the monitoring wells and the groundwater samples to be collected at Site 22, including numbers of QA/QC samples. Fixed-based laboratory analytical parameters for groundwater samples at Site 22 include the following:

- TCL chlorinated VOCs
- Natural attenuation parameters (methane, ethane, ethane, iron, manganese, alkalinity, sulfate, sulfide, nitrate, nitrite, and chloride for 6 of the 11 groundwater samples).

Field parameters to be measured for groundwater samples at Site 22 include:

- pH
- Turbidity
- Specific conductance
- Dissolved oxygen - meter
- Hydraulic conductivity
- Temperature
- Oxidation-reduction potential (ORP)
- Natural attenuation parameters (manganese, ferrous iron, alkalinity, sulfide, hydrogen sulfide, dissolved oxygen, and carbon dioxide by field test kits) for 6 of the 11 groundwater samples.

TABLE B-23

**SURFACE SOIL/SUBSURFACE SOIL SAMPLES  
SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY  
NTC GREAT LAKES, ILLINOIS  
Page 1 of 2**

Sample/ Boring No.	Sample Depth <sup>(1)</sup>	General Location	Analyses		
			TCL Chlorinated VOCs	TOC <sup>(2)</sup>	Grain Size /Porosity <sup>(2)</sup>
SUBSURFACE SOIL					
22SB01	At Depth <sup>(1)</sup> Bottom of Boring	Northwest of the Building 105	X	TBD	TBD
22SB02	At Depth <sup>(1)</sup>	East of Building 105	X	TBD	TBD
22SB03	At Depth <sup>(1)</sup>	Inside Building 105, along cracks in floor	X	TBD	TBD
22SB04	At Depth <sup>(1)</sup> Clean Bottom of Boring	Southwest edge of Building 105	X	TBD	TBD
22SB05	0-1 At Depth <sup>(1)</sup> Clean Bottom of Boring	Inside the southern end of Building 105	X	TBD	TBD
22SB06	0-1 At Depth <sup>(1)</sup> Clean Bottom of Boring	Former grease catch basin area	X	TBD	TBD
22SB07	0-1 At Depth <sup>(1)</sup> Clean Bottom of Boring	East of former grease catch basin area	X	TBD	TBD
22SB08	0-1 At Depth <sup>(1)</sup>	Outside, southwest corner of Building 105	X	TBD	TBD
22SB09	At Depth <sup>(1)</sup>	South of Building 105	X	TBD	TBD
22SB10	At Depth <sup>(1)</sup>	Eastern edge of Building 105	X	TBD	TBD
22SB11	0-1 At Depth <sup>(1)</sup> Clean Bottom of Boring	Eastern edge of Building 105	X	TBD	TBD
22SB12	0-1 At Depth <sup>(1)</sup>	Inside center of Building 105	X	TBD	TBD
22SB13	0-1 At Depth <sup>(1)</sup> Clean Bottom of Boring	Eastern edge of Building 105	X	TBD	TBD
22SB14	0-1 At Depth <sup>(1)</sup>	Inside southwestern corner of Building 105 near drain area	X	TBD	TBD
22SB15	0-1 At Depth <sup>(1)</sup> Clean Bottom of Boring	Upgradient of former grease catch basin area	X	TBD	TBD
22SB16	At Depth <sup>(1)</sup> Clean Bottom of Boring	South of Building 105	X	TBD	TBD

TABLE B-23

**SURFACE SOIL/SUBSURFACE SOIL SAMPLES  
SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY  
NTC GREAT LAKES, ILLINOIS  
Page 2 of 2**

Sample/ Boring No.	Sample Depth <sup>(1)</sup>	General Location	Analyses		
			TCL Chlorinated VOCs	TOC <sup>(2)</sup>	Grain Size /Porosity <sup>(2)</sup>
22SB17	0-1 At Depth <sup>(1)</sup> Clean Bottom of Boring	Southeast corner of Building 105	X	TBD	TBD
22SB18	At Depth <sup>(1)</sup> Clean Bottom of Boring	Southeast of Building 105	X	TBD	TBD

- 1 Chlorinated VOC samples to be collected from 0 to 1 foot in the soil below the liner or 0 to 1 foot bgs and at a discrete 1-foot interval from 1 foot to top of groundwater based on the following: elevated PID readings; visual observations of contamination/non-native soils; immediately above the water table (if encountered prior to 10 feet). Ten surface soil samples will be collected and the remaining 30 samples will be subsurface soil samples.
- 2 To be collected from 6 arbitrary soil samples.

TBD = To be determined  
TOC = Total organic carbon  
TCL = Target Compound List

PID = Photoionization detector  
VOCs = Volatile organic compounds

**TABLE B-24**  
**FIELD SAMPLE SUMMARY - SOIL**  
**SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY**  
**NTC GREAT LAKES, ILLINOIS**

Analysis	Methodology	Samples	Duplicates	Rinsate Blanks	Trip Blanks	Ambient Blanks	Matrix Spike/ Matrix Spike Duplicates	Total <sup>(1)</sup>
<b>Surface/Subsurface Soil</b>								
TCL Chlorinated VOCs	SW-846 Methods 5035/8260B	40	4	NA	TBD	TBD	1	44
TCLP Organics (IDW samples only)	SW-846 Method 1311/8260B/8270C/8081A/8151A	3	NA	NA	TBD	NA	NA	3
TCLP Inorganics (IDW samples only)	SW-846 1311/6010B/7000A series	3	NA	NA	NA	NA	NA	3
Total Organic Carbon	Walkley Black	6	NA	NA	NA	NA	NA	6
Grain Size/Porosity	ASTM D422	6	NA	NA	NA	NA	NA	6

1 Does not include the number of trip or ambient blanks.

TCL = Target Compound List

VOCs = Volatile organic compounds

TCLP = Toxicity Characteristic Leaching Procedure

TBD = To be determined. Number of samples will be determined on site depending on conditions encountered during sampling.

NA = Not applicable

**TABLE B-25**  
**WELL SUMMARY**  
**SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY**  
**NTC GREAT LAKES, ILLINOIS**

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WELL NAME	WELL LOCATION	ESTIMATED DEPTH (bgs)	ESTIMATED SCREENED INTERVAL (bgs)
NTC22MW01S	Northwest of Building 105	25	15-25
NTC22MW02S	East of Building 105	25	15-25
NTC22MW03S	Inside Building 105, along cracks in floor	25	15-25
NTC22MW04S	Southwest of Building 105	25	15-25
NTC22MW05S	Inside the southern end of Building 105	25	15-25
NTC22MW06S	Former grease catch basin area	25	15-25
NTC22MW06D	Former grease catch basin area	50	40-50
NTC22MW07S	East of former grease catch basin area	25	15-25
NTC22MW07D	East of former grease catch basin area	50	40-50
NTC22MW08S	Outside, southwest corner of Building 105	25	15-25
NTC22MW09S	South of Building 105	25	15-25

bgs = Below ground surface

**TABLE B-26**

**GROUNDWATER SAMPLES  
SITE 22- BUILDING 105 OLD DRY CLEANING FACILITY  
NTC GREAT LAKES, ILLINOIS**

Well/ Sample Number	General Location	Analysis		
		TCL Chlorinated VOCs	Natural Attenuation Parameters <sup>(1)</sup>	Field Parameters <sup>(1)</sup>
GROUND WATER				
22MW01S	Northwest of Building 105	X	X	X
22MW02S	East of Building 205	X	-	X
22MW03S	Inside Building 205, along cracks in floor	X	X	X
22MW04S	Southwest of Building 205	X	-	X
22MW05S	Inside the southern end of Building 205	X	X	X
22MW06S	Former grease catch basin area	X	X	X
22MW06D	Former grease catch basin area	X	X	X
22MW07S	East of former grease catch basin area	X	-	X
22MW07D	East of former grease catch basin area	X	-	X
22MW08S	Outside, southwest corner of Building 205	X	-	X
22MW09S	South of Building 205	X	X	X

1 Natural attenuation parameters include: methane, ethane, ethane, dissolved iron and manganese, nitrate, nitrite, chloride, sulfate, sulfide, alkalinity, carbon dioxide, dissolved oxygen, hydrogen sulfide, ferrous iron, and total organic carbon.

2 Field parameters are pH, turbidity, specific conductance, dissolved oxygen, temperature, and oxidation-reduction potential (ORP).

VOCs = Volatile organic compounds

**TABLE B-27**  
**FIELD SAMPLE SUMMARY - GROUNDWATER**  
**SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY**  
**NTC GREAT LAKES, ILLINOIS**

Analysis	Methodology	Samples	Duplicates	Rinsate Blanks	Trip Blanks	Ambient Blanks	Matrix Spike/ Matrix Spike Duplicates	Total <sup>(1)</sup>
<b>Ground Water</b>								
TCL Chlorinated VOCs	SW-846 Method 8260B	11	1	1	3	NA	1	13
TCLP Organics (IDW samples only)	SW-846 Method 1311/8260B/8270C/8081A/8151A	2	0	NA	NA	NA	NA	2
TCLP Inorganics (IDW samples only)	SW-846 1311/6010B/7000A series	2	0	NA	NA	NA	NA	2
Methane, Ethane, Ethene	RSK SOP 147 and 175	6	1	NA	NA	NA	NA	7
Iron, Manganese	SW-846 6010B	6	1	NA	NA	NA	NA	7
Nitrate, Nitrite, Chloride, Sulfate	U.S. EPA 300.0 series	6	1	NA	NA	NA	NA	7
Sulfide	U.S. EPA 376.1	6	1	NA	NA	NA	NA	7
TOC	Walkley Black/SW-846 9060	6	1	NA	NA	NA	NA	7
Field natural attenuation parameters	Field Test Kits	6	1	NA	NA	NA	NA	7
Field parameters	Field Meter <sup>(2)</sup>	11	NA	NA	NA	NA	NA	11

1 Does not include the number of trip or ambient blanks.

2 Field parameters include temperature, pH, specific conductance, turbidity, ORP and dissolved oxygen.

TCL = Target Compound List

VOCs = Volatile organic compounds

TOC = Total organic carbon

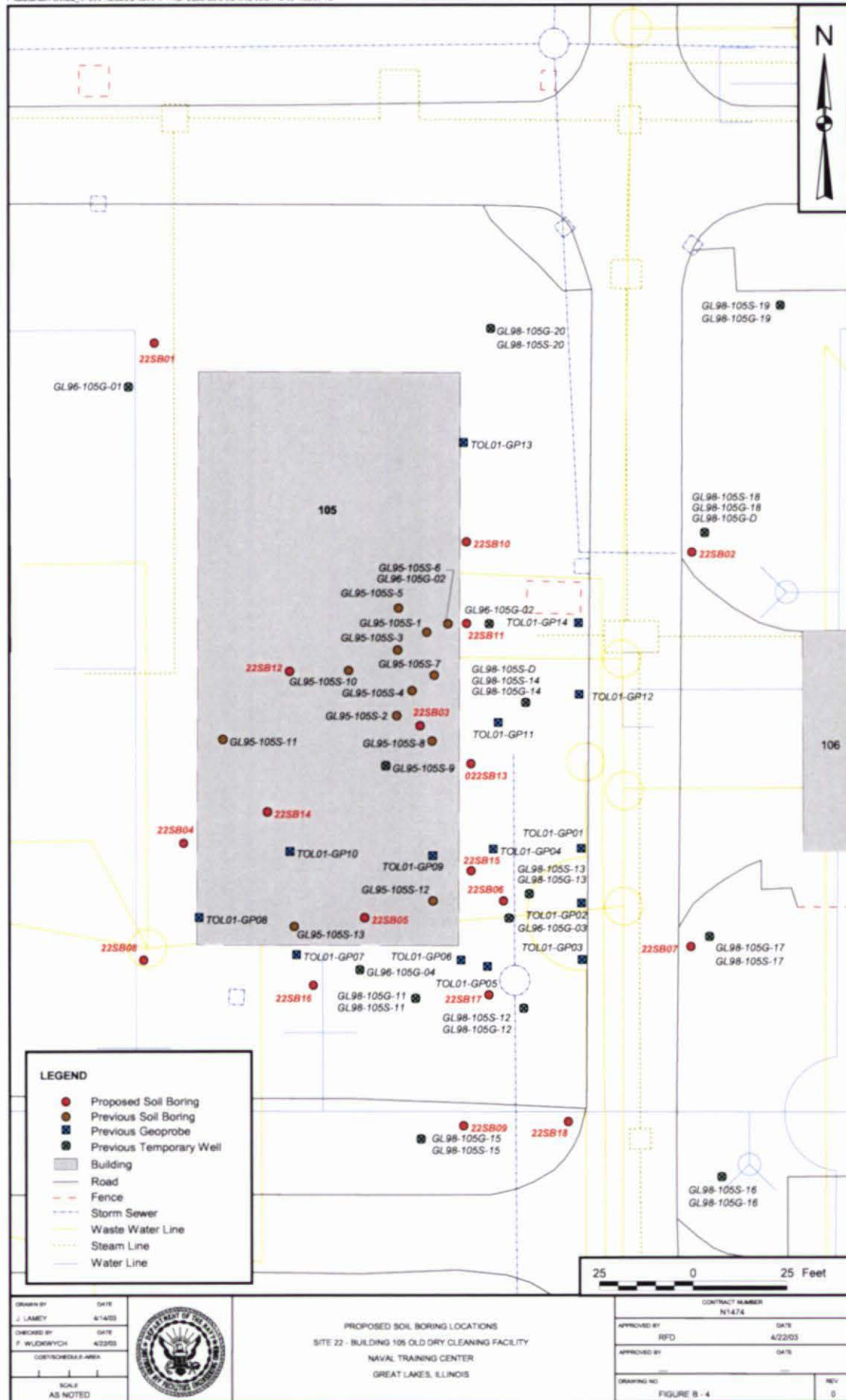
TCLP = Toxicity Characteristics Leaching Procedure

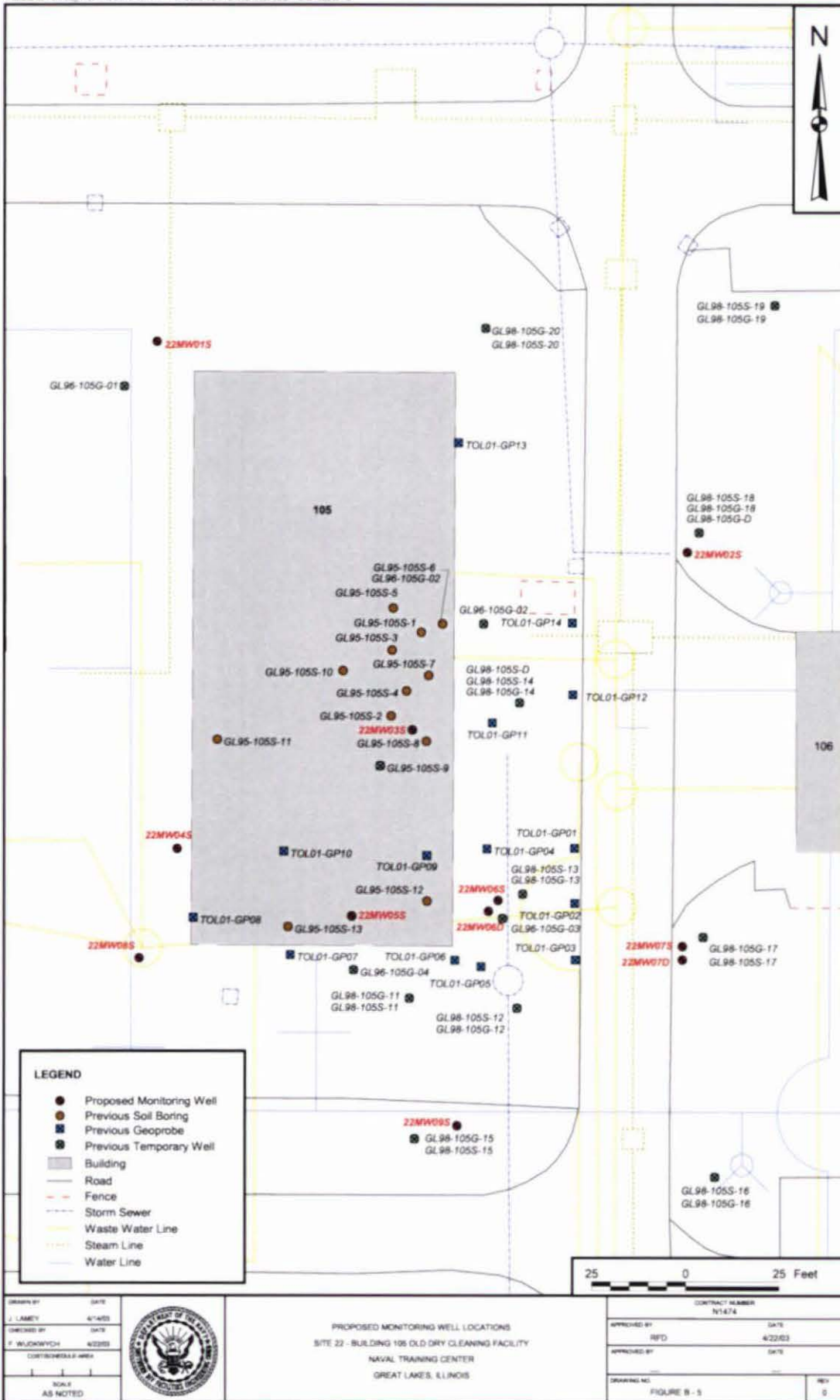
TBD = To be determined. Number of samples will be determined on site depending on conditions during sampling.

ORP = Oxidation-reduction potential

NA = Not applicable.







## REFERENCES

Illinois Environmental Protection Agency, 1996 Revised 2003. Tiered Approach to Corrective Action Objectives (TACO). Illinois Environmental Protection Agency, Bureau of Land, available at <http://www.epa.state.il.us/land/taco/>, accessed online February 2003.

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U.S. Environmental Protection Agency (U.S. EPA), 2002. Region 9 Preliminary Remediation Goals (PRGs), U.S. EPA Region 9, 75 Hawthorne Street, San Francisco, California, 94105, October.

U.S. EPA, 2001. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24, Office of Solid Waste and Emergency Response. Washington, D.C.

## **APPENDIX I**

### **HUMAN HEALTH RISK ASSESSMENT WORK PLAN**

### **I.3 SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY**

## SITE 22 - HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

This section is an addendum to Appendix I.1 of the existing Quality Assurance Project Plan (QAPP) (TtNUS, 2001) at NTC Great Lakes. The investigation at Site 22 – Building 105 Old Dry Cleaner Facility will be similar to the investigation at Site 7. The human health risk assessment methodology for Site 22 presented in the following sections will follow the methodology for Site 7 presented in Appendix I.1 of this QAPP, unless otherwise noted. Changes to the methodology specific to the investigation at Site 22 – Building 105 Old Dry Cleaning Facility are provided below

In addition to the documents used for Site 7, the following new or updated risk assessment guidance documents were used to develop the framework for the Baseline Human Health Risk Assessment:

- U.S. EPA, 2001. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24, Office of Solid Waste and Emergency Response. Washington, D.C.
- IEPA, 2003. TACO (Tiered Approach to Corrective Action Objectives). Illinois Environmental Protection Agency, Bureau of Land, available at <http://www.epa.state.il.us/land/taco/>, accessed online February 2003.

### 1.0 DATA EVALUATION

Data evaluation for Site 22 will follow the methodology described in Section 1.0 of the Work Plan for Site 7 (Appendix I.1). However, the screening concentrations will be updated to reflect the most recent values provided by IEPA and the U. S. EPA. At the present time (May 2003), the screening criteria are based on the following:

#### Screening Levels for Soil

- IEPA Tier 1 Soil Remediation Objectives for Residential Properties (IEPA, February 2003) for the soil ingestion exposure route and for the inhalation exposure route.
- U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for Residential Soil (U.S. EPA, October 2002).
- IEPA Tier 1 Soil Remediation Objectives for Residential Properties for the Soil Component of the Groundwater Ingestion Exposure Route (IEPA, February 2003).
- U.S. EPA Region 3 Soil Screening Levels (SSLs) for Migration to Groundwater (U.S. EPA, October 2002).

### Screening Concentrations for Groundwater

- IEPA Tier 1 Groundwater Remediation Objectives for Class 1 Groundwater (IEPA, February 2003).
- U.S. EPA Region 9 PRGs for Tap Water (U.S. EPA, October 2002).
- U.S. EPA Maximum Contaminant Levels (MCLs) (U.S. EPA, Summer 2002).

### Surface Water and Sediment

Potential risks from exposure to surface water and sediment at Site 22 will not be evaluated because surface water and sediment do not exist on the site.

## **2.0 EXPOSURE ASSESSMENT**

The exposure assessment for Site 22 will follow the methodology described in Section 2.0 of the Work Plan for Site 7. The following sections provide information specific to the Site 22 risk assessment.

### **2.1 Conceptual Site Model**

The conceptual site model (CSM) for Site 22 is illustrated in Figure 1. The CSM will be refined during the risk assessment process using the data collected as part of the proposed field investigations. Table 1 presents a summary of the exposure routes that will be addressed quantitatively for each human receptor. The elements of the CSM as they pertain to Site 22 are presented in the following sections.

#### **2.1.1 Site Sources of Contamination**

Building 105 was constructed in 1939 and was utilized as a dry cleaning facility until 1993 or 1994 when it was converted to a vending machine supply and repair station. Soil and groundwater contamination is thought to have occurred via spills or leaks of chemicals associated with the dry cleaning process, especially PCE and its degradation products. PCE has been detected in historical soil samples at concentrations ranging from 10 to 1,500,000 ug/kg and in groundwater samples at concentrations ranging from 2 to 7,400 ug/L. Because of the high concentrations of VOCs detected in soil and groundwater, the following additional (i.e., in addition to those evaluated for Site 7) exposure scenarios will be evaluated in the risk assessment for Site 22:

- Exposure of potential receptors [i.e., current worker receptor (full time commercial/industrial workers), trespassers, future residents] to vapors emitted from soil or groundwater in outdoor ambient air (Section 2.1.3.1).
- Exposure of hypothetical future on-site residents to vapors in indoor air. The vapors may be emitted from soil and/or groundwater (Section 2.1.3.2).
- Exposure of hypothetical future on-site workers (e.g., office workers) to vapors in buildings. The vapors may be emitted from soil and/or groundwater (Section 2.1.3.2).
- Exposure of hypothetical future on-site residents to vapors while showering with groundwater (Section 2.1.3.3).
- Exposure of future construction workers in a trench to vapors emitted from groundwater (see Section 2.1.3.4).

Exposure to fugitive dust and vapors from soil will also be evaluated semi-quantitatively by comparing maximum chemical concentrations in soil to IEPA TACO and U.S. EPA Generic SSLs for inhalation. If the maximum concentration of a chemical exceeds its SSL, potential risks from inhalation of that chemical will be quantitatively evaluated in the risk assessment according to guidance set forth in Risk Assessment Guidance for Superfund (RAGS) Part A (U.S. EPA, December 1989) and the U.S. EPA's Soil Screening Guidance (U.S. EPA, July 1996 and December 2002).

### **2.1.2 Potential Receptors**

Potential receptors at Site 22 include those described in Section 2.1.4 of the Site 7 Work Plan, plus one additional receptor, the future occupational worker. Therefore, the receptors evaluated for Site 22 include: maintenance workers, construction workers, occupational workers, adolescent trespassers, future military residents, and future civilian residents. Future occupational workers were added to account for the possibility that NTC might be developed for commercial/industrial uses at some future time and to provide information that may be necessary for risk management decisions. Occupational workers are assumed to be exposed to soil 219 days/year for 9 years for the Central Tendency Exposure (CTE) and 250 days/year for 25 years for the Reasonable Maximum Exposure (RME). To account for the possibility that future workers might work inside buildings constructed on the site and inhale vapors emitted from soil or groundwater that migrate through cracks in building foundations and walls, these receptors will also be evaluated for inhalation of vapors inside buildings.



### 2.1.3 Chemical Intake Estimation

Future occupational workers will be added to the risk assessment for Site 22. These receptors are assumed to be exposed on the head, hands, and forearms (assuming that they wear a short-sleeved shirt, long pants, and shoes) for dermal contact with soil,. As recommended in RAGS Part E (U.S. EPA, September 2001), this skin surface area is assumed to be 3,300 cm<sup>2</sup> for the RME and CTE scenarios. This value represents the average of the 50<sup>th</sup> percentile areas of males and females more than 18 years old. The workers are assumed to ingest 100 mg/day of soil for the RME and 50 mg/day for the CTE and to inhale indoor and outdoor air at the rate of 20 m<sup>3</sup>/day.

As discussed in Section 2.1.1, several additional exposure scenarios have been added to the risk assessment for Site 22 to account for the inhalation of VOCs detected in historical samples at the site. Details of the inhalation exposure pathways are presented in the following subsections. Values of the exposure parameters and assumptions for the additional receptor and exposure pathways are presented in Tables 2 through 13.

#### 2.1.3.1 Inhalation of Outdoor Ambient Air Containing Volatiles Emitted from Groundwater

Potential receptors may be exposed to VOCs that have volatilized from groundwater, through soil, and into ambient air. Ambient air concentrations resulting from the volatilization of chemicals in groundwater to outdoor air will be calculated by using the following equation from American Society for Testing and Materials (ASTM) Standard Guide for Risk-Based Corrective Action (ASTM, 2000).

$$C_{\text{air}} = VF_{\text{gw,amb}} \cdot C_{\text{gw}} \cdot 10^3 \frac{\text{L}}{\text{m}^3}$$

where:  $C_{\text{air}}$  = chemical concentration in indoor air, mg/m<sup>3</sup>  
 $VF_{\text{gw,amb}}$  = volatilization factor from groundwater to indoor air, cm<sup>3</sup>-water/cm<sup>3</sup>-air  
 $C_{\text{gw}}$  = chemical concentration in groundwater, mg/L

The volatilization factor,  $VF_{\text{gw,amb}}$ , is calculated as follows:

$$VF_{\text{gw}} = \frac{1}{\left[ 1 + \frac{DF_{\text{amb}} \cdot L_{\text{GW}}}{D_{\text{ws}}^{\text{eff}}} \right] \cdot \frac{1}{H'}} \cdot 10^3 \cdot \frac{\text{L}}{\text{m}^3}$$

and

$$DF_{amb} = \frac{U_{air} \cdot W \cdot d_{air}}{A}$$

where: $VF_{gw}$	=	volatilization factor for groundwater, (L/m <sup>3</sup> )
$H'$	=	Henry's law constant, chemical specific, (cm <sup>3</sup> -H <sub>2</sub> O)/(cm <sup>3</sup> -air)
$L_{GW}$	=	depth to groundwater, (cm)
	=	$h_v + h_{cap}$
$h_v$	=	thickness of vadose zone, (cm)
$h_{cap}$	=	thickness of capillary fringe; (cm)
$D_{ws}^{eff}$	=	effective diffusion coefficient between groundwater and surface soil, chemical specific, (cm <sup>2</sup> /sec)
$DF_{amb}$	=	dispersion factor for outdoor air, (cm/sec)
$U_{air}$	=	wind speed above ground surface in mixing zone, (cm/sec)
$d_{air}$	=	ambient air mixing zone, (cm)
$W$	=	width of source parallel to groundwater flow direction, (cm)
$A$	=	source-zone area, (cm <sup>2</sup> )

The effective diffusion coefficient between groundwater and surface soil,  $D_{ws}^{eff}$ , is calculated as follows:

$$D_{ws}^{eff} = \frac{L_{gw}}{(h_v/D_v^{eff}) + (h_{cap}/D_{cap}^{eff})}$$

Where: $D_{cap}^{eff}$	=	effective diffusion through capillary fringe, chemical specific, cm <sup>2</sup> /sec
$D_v^{eff}$	=	effective diffusion in vadose zone soil based on vapor-phase concentration, chemical specific, cm <sup>2</sup> /sec

The effective diffusion through the capillary fringe,  $D_{cap}^{eff}$ , is calculated from:

$$D_{cap}^{eff} = D^{air} \cdot \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^{wat} \cdot \frac{1}{H} \cdot \frac{\theta_{wcap}^{3.33}}{\theta_T^2}$$

where: $D^{air}$	=	diffusion coefficient in air, chemical specific, cm <sup>2</sup> /sec
$D^{wat}$	=	diffusion coefficient in water, chemical specific, cm <sup>2</sup> /sec

$\theta_{\text{acap}}$  = volumetric air content in capillary fringe soils,  $0.038 \text{ cm}^3\text{-air/cm}^3\text{-soil}$   
 $\theta_{\text{wcap}}$  = volumetric water content in capillary fringe soils,  $0.342 \text{ cm}^3\text{-H}_2\text{O/cm}^3\text{-soil}$   
 $\theta_T$  = total soil porosity,  $0.38 \text{ cm}^3/\text{cm}^3\text{-soil}$

Input assumptions for the volatilization from groundwater to outdoor air model will be presented in an appendix to the risk assessment. Site-specific values will be used whenever possible. Model default values will be used when they are believed to be representative of site conditions. Chemical properties will be obtained from the Soil Screening Guidance: User's Guide (U.S. EPA, July 1996 and March 2001), the Hazardous Substance Data Base (HSDB) (<http://toxnet.nlm.nih.gov>), or the Risk Assessment Information System (RAIS), Office of Environment (<http://risk.lsd.ornl.gov>).

Intakes of vapors from groundwater will be calculated using the air concentration estimated by the above model and the following equation (U.S. EPA, December 1989):

$$\text{Intake}_{\text{air}} = (C_{\text{air}})(IR_a)(ET)(EF)(ED) / (BW)(AT)$$

where:  $\text{Intake}_{\text{ai}}$  = intake of chemical "i" from air via inhalation (mg/kg/day)  
 $C_{\text{air}}$  = concentration of chemical "i" in air (mg/m<sup>3</sup>) (calculated)  
 $IR_a$  = inhalation rate (m<sup>3</sup>/hr)  
 $ET$  = exposure time (hours/day)  
 $EF$  = exposure frequency (days/yr)  
 $ED$  = exposure duration (yr)  
 $BW$  = body weight (kg)  
 $AT$  = averaging time (days)  
for noncarcinogens,  $AT = ED \times 365 \text{ days/yr}$   
for carcinogens,  $AT = 70 \text{ yrs} \times 365 \text{ days/yr}$

An inhalation rate of 20 m<sup>3</sup>/day (U.S. EPA, December 2002) will be used to calculate the inhalation intake for current worker receptor (full time commercial/industrial workers), maintenance workers, future occupational workers, and future adult residents. The inhalation rates for adolescent trespassers will be 1.9 m<sup>3</sup>/hour for the RME and 1.2 m<sup>3</sup>/hour for the CTE (U.S. EPA, August 1997).

### 2.1.3.2 Inhalation of Volatiles from Soil and Groundwater inside Buildings by Vapor Intrusion

Volatilization of chemicals from soil and groundwater into indoor air may occur, thereby exposing individuals inside buildings or dwellings. Therefore, potential risks associated with chemical concentrations in indoor air as a result of vapor migration from impacted soil or groundwater will be evaluated for hypothetical future on-site residents. The Johnson and Ettinger Vapor Intrusion Model (U.S. EPA, December 2000) will be used to determine the indoor air concentration of a chemical that is present in groundwater. The model assumes that vapors of volatile chemicals are emitted from soil or groundwater, migrate through cracks in building foundations, and accumulate in air inside buildings. The Johnson and Ettinger Model assumes that residential dwellings or commercial buildings have been constructed on the site and that the dimensions and ventilation rates of these buildings are typical of residential dwellings in the United States.

The volatility of a chemical largely determines the significance of this route of exposure. Indoor air concentrations of a chemical will be influenced by the physical and chemical properties of the substance, especially solubility and vapor pressure. Low aqueous solubilities and high vapor pressures increase the likelihood that organic compounds found in water will also be found in indoor air. Additionally, the physical properties of the soil can have a great influence on the rate of diffusion of chemicals through the soil.

The following equation is used to assess intakes for inhalation of indoor air:

$$\text{Intake} = \frac{\text{IR}_a \times \text{EF} \times \text{ED} \times \text{C}_{\text{building}}}{\text{AT} \times \text{BW}}$$

where: Intake	= intake of chemical from air (mg/kg-day)
IR <sub>a</sub>	= inhalation rate (m <sup>3</sup> /day)
EF	= exposure frequency (days/year)
ED	= exposure duration (years)
C <sub>building</sub>	= vapor concentration in the building (mg/m <sup>3</sup> ) as calculated by the model
AT	= averaging time (days) for noncarcinogens, AT = ED x 365 days/year for carcinogens, AT = 70 years x 365 days/year
BW	= body weight (kg)

A discussion of the major assumptions and limitations of the Johnson and Ettinger Model will be provided in the uncertainty section of the risk assessment. Additional assumptions are contained in Section 5 of the Model Users Guide (U.S. EPA, December 2000). Indoor inhalation rates are set at 20 m<sup>3</sup>/day for adult residents and occupational workers (U.S. EPA, December 2002) and 10 m<sup>3</sup>/day for child residents (USEPA, August 1997).

### 2.1.3.3 Inhalation of Volatiles in Groundwater While Showering

Groundwater exposure may also result in inhalation of volatiles, typically for residential receptors who may be exposed while showering, bathing, washing dishes, etc. Inhalation exposures are estimated using a mass transfer model developed specifically for this exposure route in combination with an air intake estimation model. The mass transfer model accounts for inhalation that occurs during a shower and after a shower while the receptor remains in the closed bathroom. The method used is as follows (Foster and Chrostowski, 1987):

$$\text{Intake}_{si} = (S)(IR_{sh})(K)(EF)(ED) / (BW)(AT)(R_a)(CF)$$

$$K = D_s + \frac{\exp(-R_a \times D_t)}{R_a} - \frac{\exp R_a \times (D_s - D_t)}{R_a}$$

where: Intake <sub>wi</sub>	=	intake of chemical "i" from water via inhalation (mg/kg/day)
S	=	volatile chemical generation rate (ug/m <sup>3</sup> -min - shower)
IR <sub>sh</sub>	=	inhalation rate (L/min)
K	=	mass transfer coefficient (min)
EF	=	exposure frequency (showers/yr)
ED	=	exposure duration (yr)
BW	=	body weight (kg)
AT	=	averaging time or period of exposure (days)
R <sub>a</sub>	=	air exchange rate (min <sup>-1</sup> )
CF	=	conversion factor (1 x 10 <sup>6</sup> ug-L/mg-m <sup>3</sup> )
D <sub>s</sub>	=	shower duration (min)
D <sub>t</sub>	=	total time in bathroom (min)

The estimated volatile chemical generation rate is based on two-phase film theory. The model uses contaminant-specific mass transfer coefficients, Henry's Law constants, droplet diameter, drop time, viscosity, and temperature. Shower inhalation rates are set at 10 L/min for adult and child residents (U.S. EPA, 1989). The shower model calculations will be presented in an appendix to the risk assessment.

#### 2.1.3.4 Exposure of Workers to Volatiles in a Construction/Utility Trench

There are no well-established models available for estimating migration of volatiles from groundwater into a construction/utility trench. This risk assessment will use an approach suggested by the Virginia Department of Environmental Quality (VDEQ, online September 2002) that is based on a combination of a vadose zone model to estimate volatilization of gases from contaminated groundwater into a trench and a box model to estimate dispersion of the contaminants from the air inside the trench into the above-ground atmosphere to estimate the exposure point concentration (EPC) for air in a construction trench. The VDEQ methodology is described in the following sections.

The airborne concentration of a contaminant in a trench can be estimated using the following equation:

$$C_{\text{trench}} = C_{\text{GW}} \times \text{VF}$$

where:  $C_{\text{trench}}$  = air concentration of contaminant in the trench (ug/m<sup>3</sup>)

$C_{\text{GW}}$  = concentration of contaminant in groundwater (ug/L)

VF = volatilization factor (L/m<sup>3</sup>)

The model used in this risk assessment assumes that a construction project could result in an excavation to 15 feet bgs or less. If the depth to groundwater at a site is less than 15 feet, the VDEQ model assumes that a worker would encounter groundwater when digging an excavation or a trench. The worker would then have direct exposure to the groundwater. The worker would also be exposed to contaminants in the air inside the trench that would result from volatilization from the groundwater pooling at the bottom of the trench.

The following equation is used to calculate VF for a trench less than 15 feet deep:

$$\text{VF} = (K_i \times A \times F \times 10^{-3} \times 10^4 \times 3,600) / (ACH \times V)$$

where:  $K_i$  = overall mass transfer coefficient of contaminant (cm/s)

A = area of the trench (m<sup>2</sup>)

F = fraction of floor through which contaminant can enter (unitless)

ACH = air changes per hour =  $360 \text{ h}^{-1}$

V = volume of trench ( $\text{m}^3$ )

$10^{-3}$  = conversion factor ( $\text{L}/\text{cm}^3$ )

$10^4$  = conversion factor ( $\text{cm}^2/\text{m}^2$ )

3,600 = conversion factor (seconds/hr)

Studies of urban canyons suggest that if the ratio of trench width to trench depth, relative to wind direction, is less than or equal to 1, a circulation cell or cells will be set up within the trench that limits the degree of gas exchange with the atmosphere and the ACH is assumed to be of 2/hr based on measured ventilation rates of buildings. If the ratio of trench width to trench depth is greater than one, air exchange between the trench and above-ground atmosphere is not restricted, and ACH is assumed to be 360/hr based upon the ratio of trench depth to the average wind speed. This risk assessment assumes that the width to trench depth ratio is greater than 1. The use of this width-to-trench ratio is appropriate for Site 22 because it would be more applicable to excavating building foundations than to working in narrower spaces. Therefore, ACH is assumed to be  $360 \text{ h}^{-1}$ .

The overall mass transfer coefficient ( $K_i$ ) is calculated as follows:

$$K_i = 1 / \{ (1/k_i L) + [(RT) / (H_i k_i G)] \}$$

where:  $k_i L$  = liquid-phase mass transfer coefficient of i cm/s

R = ideal gas constant ( $\text{atm}\cdot\text{m}^3/\text{mole}\cdot^\circ\text{K}$ ) =  $8.2 \times 10^{-5}$

T = average system absolute temperature ( $^\circ\text{K}$ ) (Default =  $298^\circ\text{K}$ )

$H_i$  = Henry's Law constant of i ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )

$K_i G$  = gas-phase mass transfer coefficient of i (cm/s)

where:  $k_i L = (\text{MWO}_2/\text{MW}_i)^{0.5} \times (T/298) \times k_{L, \text{O}_2}$

$k_i L$  = liquid-phase mass transfer coefficient of component i (cm/s)

$\text{MWO}_2$  = molecular weight of  $\text{O}_2$  (g/mol)

$\text{MW}_i$  = molecular weight of component i (g/mol)

$k_{L, \text{O}_2}$  = liquid-phase mass transfer coefficient of oxygen at  $25^\circ\text{C}$  (cm/s)

The value of  $k_{L, \text{O}_2}$  is  $0.002 \text{ cm/s}$ .

$$k_i G = (\text{MWH}_2\text{O}/\text{MW}_i)^{0.335} \times (T/298)^{1.005} \times k_{G, \text{H}_2\text{O}}$$

where:  $k_iG$  = gas-phase mass transfer coefficient of component  $i$  (cm/s)  
 $MW_{H_2O}$  = molecular weight of water (g/mol)  
 $k_{G,H_2O}$  = gas-phase mass transfer coefficient of water vapor at 25°C (cm/s)

The value of  $k_{G,H_2O}$  is 0.833 cm/s (Superfund Exposure Assessment Manual, U. S. EPA, April 1988)

Exposures for construction workers associated with the inhalation route are estimated in the following manner (U.S. EPA, December 1989):

$$\text{Intake}_{ai} = \frac{(C_{ai})(IR_a)(ET)(EF)(ED)}{(BW)(AT)}$$

where:  $\text{Intake}_{ai}$  = intake of chemical "i" from air via inhalation (mg/kg/day)  
 $C_{ai}$  = concentration of chemical "i" in air (mg/m<sup>3</sup>)  
 $IR_a$  = inhalation rate (m<sup>3</sup>/hr) = 2.5 m<sup>3</sup>/hr (U.S. EPA, December 2002)  
 $ET$  = exposure time (hours/day)  
 $EF$  = exposure frequency (days/yr)  
 $ED$  = exposure duration (yr)  
 $BW$  = body weight (kg)  
 $AT$  = averaging time (days)  
 for noncarcinogens,  $AT = ED \times 365 \text{ days/yr}$   
 for carcinogens,  $AT = 70 \text{ yr} \times 365 \text{ days/yr}$

Input assumptions for the volatilization from groundwater to outdoor air model will be presented in an appendix to the risk assessment. Site-specific values will be used whenever possible. Model default values will be used when they are believed to be representative of site conditions. Chemical properties will be obtained from the Soil Screening Guidance (U.S. EPA, December 2001) and will be presented with the model calculations.

### 3.0 TOXICITY ASSESSMENT

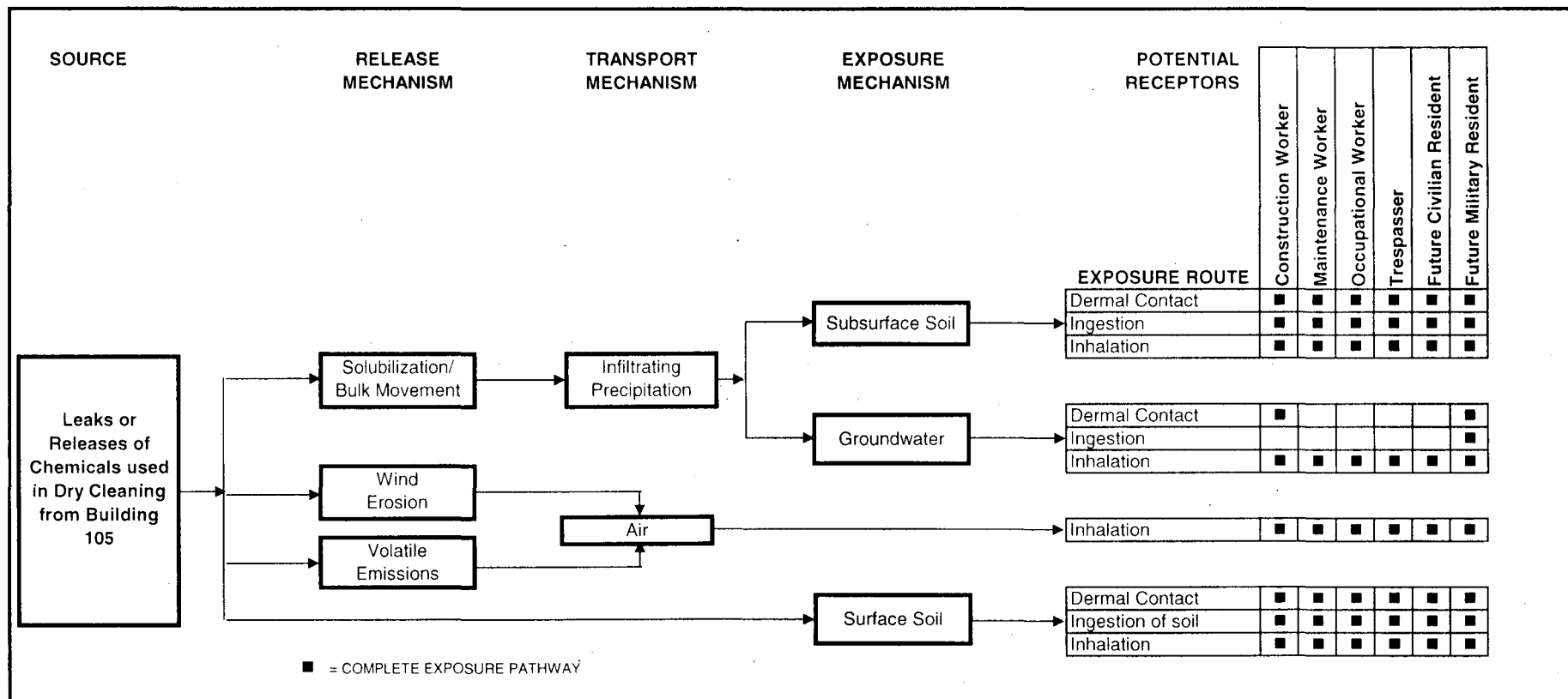
The Toxicity Assessment for Site 22 will be similar to that of Site 7. However, the toxicity discussion will be adapted to account for the types of chemicals detected at Site 22. Toxicological profiles for each COPC will be presented in an appendix to the risk assessment. These brief profiles will present a



summary of the currently available literature on the carcinogenic and noncarcinogenic health effects associated with human exposure to the COPCs.

FIGURE .

HUMAN HEALTH CONCEPTUAL SITE MODEL  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS



Blank space indicates incomplete exposure pathway or relatively insignificant, or not applicable potential exposure.

**SITE 22 - TABLE 1**

**EXPOSURE ROUTES FOR QUANTITATIVE EVALUATION  
SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY  
NTC GREAT LAKES, ILLINOIS**

<b>Receptors</b>	<b>Exposure Routes</b>
Maintenance Workers (current/future land use)	<ul style="list-style-type: none"> <li>• Soil Dermal Contact</li> <li>• Soil Ingestion</li> <li>• Inhalation of Air/Dust/Emissions (from soil)</li> <li>• Inhalation of Outdoor Ambient Air (vapors from groundwater)</li> </ul>
Adolescent Trespassers (7 to 16 Years) (future land use)	<ul style="list-style-type: none"> <li>• Soil Dermal Contact</li> <li>• Soil Ingestion</li> <li>• Inhalation of Air/Dust/Emissions (from soil)</li> <li>• Inhalation of Outdoor Ambient Air (vapors from groundwater)</li> </ul>
Construction Workers (future land use)	<ul style="list-style-type: none"> <li>• Soil Dermal Contact</li> <li>• Soil Ingestion</li> <li>• Inhalation of Air/Dust/Emissions (from soil)</li> <li>• Groundwater Dermal Contact (during excavation)</li> <li>• Groundwater Inhalation of Volatile Organics (during excavation)</li> </ul>
Occupational Workers (future land use)	<ul style="list-style-type: none"> <li>• Soil Dermal Contact</li> <li>• Soil Ingestion</li> <li>• Inhalation of Air/Dust/Emissions (from soil)</li> <li>• Inhalation of Outdoor Ambient Air (vapors from groundwater)</li> <li>• Inhalation of Indoor Air (vapors from soil and groundwater)</li> </ul>
On-Base Military Residents (Adult/Children) (future land use)	<ul style="list-style-type: none"> <li>• Soil Dermal Contact</li> <li>• Soil Ingestion</li> <li>• Inhalation of Air/Dust/Emissions (from soil)</li> <li>• Inhalation of Outdoor Ambient Air (vapors from groundwater)</li> <li>• Inhalation of Indoor Air (vapors from soil and groundwater)</li> </ul>
On-site Civilian Residents (Adult/Children) (future land use)	<ul style="list-style-type: none"> <li>• Soil Dermal Contact</li> <li>• Soil Ingestion</li> <li>• Inhalation of Air/Dust/Emissions (from soil)</li> <li>• Inhalation of Outdoor Ambient Air (vapors from groundwater)</li> <li>• Inhalation of Indoor Air (vapors from soil and groundwater)</li> </ul>

**SITE 22 - TABLE 2**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF OCCUPATIONAL WORKERS TO SOIL  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future  
Medium: Soil  
Exposure Medium: Soil  
Exposure Point: Entire Site  
Receptor Population: Occupational Worker  
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	CTE Value	CTE Rationale/Reference	Intake Equation/Model Name
Ingestion	Csoil	Chemical Concentration in Soil	mg/kg	95% UCL or Max	U.S. EPA, May 1993	95% UCL or Max	U.S. EPA, May 1993	$\text{Ingestion CDI}^{(1)} (\text{mg/kg/day}) = \frac{\text{Csoil} \times \text{IR} \times \text{Fi} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{AT}}$ U.S. EPA, December 1989
	IR	Ingestion Rate of Soil	mg/day	100	U.S. EPA, May 1993	50	U.S. EPA, May 1993	
	Fi	Fraction Ingested	unitless	1.0	U.S. EPA, May 1993	1.0	U.S. EPA, May 1993	
	EF	Exposure Frequency	days/year	250	U.S. EPA, May 1993	219	U.S. EPA, May 1993	
	ED	Exposure Duration	years	25	U.S. EPA, May 1993	9	U.S. EPA, May 1993	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA, December 1989	1.0E-06	U.S. EPA, December 1989	
	BW	Body Weight	kg	70	U.S. EPA, May 1993	70	U.S. EPA, May 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25,550	U.S. EPA, December 1989	
Dermal	AT-N	Averaging Time (Non-Cancer)	days	9,125	U.S. EPA, December 1989	3,285	U.S. EPA, December 1989	$\text{Dermal CDI}^{(1)} (\text{mg/kg/day}) = \frac{\text{Csoil} \times \text{CF} \times \text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$ U.S. EPA, December 1989
	Csoil	Chemical Concentration in Soil	mg/kg	95% UCL or Max	U.S. EPA, May 1993	95% UCL or Max	U.S. EPA, May 1993	
	CF	Conversion Factor	kg/mg	1.0E-06	U.S. EPA, December 1989	1.0E-06	U.S. EPA, December 1989	
	SA	Skin Surface Area	cm <sup>2</sup> /day	3,300	U.S. EPA, September 2001	3,300	U.S. EPA, September 2001	
	AF	Soil to Skin Adherence Factor	mg/cm <sup>2</sup>	0.2	U.S. EPA, September 2001	0.02	U.S. EPA, September 2001	
	ABS	Dermal Absorption Factor (Solid)	unitless	chemical - specific	U.S. EPA, September 2001	chemical - specific	U.S. EPA, September 2001	
	EF	Exposure Frequency	days/year	250	U.S. EPA, May 1993	219	U.S. EPA, May 1993	
	ED	Exposure Duration	years	25	U.S. EPA, May 1993	9	U.S. EPA, May 1993	
	BW	Body Weight	kg	70	U.S. EPA, May 1993	70	U.S. EPA, May 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25,550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Non-Cancer)	days	9,125	U.S. EPA, December 1989	3,285	U.S. EPA, December 1989	

1 CDI = Chronic Daily Intake

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

UCL = 95 Percent Upper Confidence Limit

**SITE 22 - TABLE 3**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF MAINTENANCE WORKERS TO OUTDOOR AMBIENT AIR  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Outdoor Ambient Air
Receptor Population: Maintenance Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	CTE Value	CTE Rationale/Reference	Intake Equation/Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	ASTM E 2081-00	Derived	ASTM E 2081-00	$\text{Chronic Daily Intake (CDI) (mg/kg-day)} = \frac{\text{Cair} \times \text{IRa} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	2.5	U.S. EPA, August 1997	1.5	U.S. EPA, August 1997	
	EF	Exposure Frequency	days/year	24	Professional Judgement (2 days per month)	12	Professional Judgement (1/2 the RME )	
	ED	Exposure Duration	years	25	U.S. EPA, May 1993	9	U.S. EPA, May 1993	
	ET	Exposure Time	hr/day	8	Professional judgement	4	Professional judgement	
	BW	Body Weight	kg	70	U.S. EPA, December 1989	70	U.S. EPA, December 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	9,125	U.S. EPA, December 1989	3,285	U.S. EPA, December 1989	

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

**SITE 22 - TABLE 4**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF OCCUPATIONAL WORKERS TO OUTDOOR AMBIENT AIR  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Air  
Exposure Point: Outdoor Ambient Air  
Receptor Population: Occupational Worker  
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	ASTM E 2081-00	Derived	ASTM E 2081-00	Chronic Daily Intake (CDI) (mg/kg-day)= $\frac{C_{air} \times IR_a \times ET \times EF \times ED}{BW \times AT}$
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	2.5	U.S. EPA, March 2001	1.3	U.S. EPA, August 1997	
	EF	Exposure Frequency	days/year	250	U.S. EPA, May 1993	219	U.S. EPA, May 1993	
	ED	Exposure Duration	years	25	U.S. EPA, May 1993	9	U.S. EPA, May 1993	
	ET	Exposure Time	hr/day	8	U.S. EPA, December 2002	4	Professional judgement	
	BW	Body Weight	kg	70	U.S. EPA, December 1989	70	U.S. EPA, December 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	9,125	U.S. EPA, December 1989	3,285	U.S. EPA, December 1989	

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

**SITE 22 - TABLE 5**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF ADOLESCENT TRESPASSERS TO OUTDOOR AMBIENT AIR  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Outdoor Ambient Air
Receptor Population: Trespassers
Receptor Age: Adolescent (7 to 16 years old)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	ASTM E 2081-00	Derived	ASTM E 2081-00	$\text{Chronic Daily Intake (CDI)} \text{ (mg/kg-day)} = \frac{\text{Cair} \times \text{IRa} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	1.9	U.S. EPA, August 1997	1.2	U.S. EPA, August 1997	
	EF	Exposure Frequency	days/year	26	Professional Judgement (1 day per week in warm weather months)	13	Professional Judgement (1/2 the RME )	
	ED	Exposure Duration	years	10	Adolescent, Age 7 - 16	10	Adolescent, Age 7 - 16	
	ET	Exposure Time	hr/day	2	Professional judgement	1	Professional judgement	
	BW	Body Weight	kg	42	U.S. EPA, August 1997	42	U.S. EPA, August 1997	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	3,650	U.S. EPA, December 1989	3,650	U.S. EPA, December 1989	

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

**SITE 22 - TABLE 6**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF FUTURE ADULT RESIDENTS TO OUTDOOR AMBIENT AIR  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Outdoor Ambient Air
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	ASTM E 2081-00	Derived	ASTM E 2081-00	Chronic Daily Intake (CDI) (mg/kg-day)= Cair x IRa x ET x EF x ED BW x AT
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	20	U.S. EPA, August 1997	20	U.S. EPA, August 1997	
	EF	Exposure Frequency	days/year	350	U.S. EPA, May 1993	234	U.S. EPA, May 1993	
	ED	Exposure Duration	years	24	U.S. EPA, May 1993	7	U.S. EPA, May 1993	
	BW	Body Weight	kg	70	U.S. EPA, December 1989	70	U.S. EPA, December 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	8,760	U.S. EPA, December 1989	2,555	U.S. EPA, December 1989	

Note: The same exposure parameters are used for civilian and military adult residents, with the exception of exposure duration (ED).

Adult military residents are assumed to be exposed for a period of 6 years for the RME and CTE.

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure



# SITE 22 - TABLE 7

## VALUES USED FOR DAILY INTAKE CALCULATIONS EXPOSURE OF FUTURE CHILD RESIDENTS TO OUTDOOR AMBIENT AIR SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY NTC, GREAT LAKES, ILLINOIS

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Air  
Exposure Point: Outdoor Ambient Air  
Receptor Population: Resident  
Receptor Age: Child (0-6 Years)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	ASTM E 2081-00	Derived	ASTM E 2081-00	Chronic Daily Intake (CDI) (mg/kg-day)= $C_{air} \times I R_a \times E T \times E F \times E D$ $BW \times A T$
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	10	U.S. EPA, August 1997	10	U.S. EPA, August 1997	
	EF	Exposure Frequency	days/year	350	U.S. EPA, May 1993	234	U.S. EPA, May 1993	
	ED	Exposure Duration	years	6	U.S. EPA, May 1993	2	U.S. EPA, May 1993	
	BW	Body Weight	kg	15	U.S. EPA, May 1993	15	U.S. EPA, May 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	2,190	U.S. EPA, December 1989	730	U.S. EPA, December 1989	

Note: The same exposure parameters are used for civilian and military child residents.

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

**SITE 22 - TABLE 8**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF OCCUPATIONAL WORKERS TO INDOOR AIR  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future  
Medium: Soil/Groundwater  
Exposure Medium: Air  
Exposure Point: Indoor Air  
Receptor Population: Occupational Worker  
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	CTE Value	CTE Rationale/Reference	Intake Equation/Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	ASTM E 2081-00	Derived	ASTM E 2081-00	Chronic Daily Intake (CDI) (mg/kg-day)= $\frac{C_{air} \times I_{Ra} \times ET \times EF \times ED}{BW \times AT}$
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	2.5	U.S. EPA, December 2002	2.5	U.S. EPA, March 2001	
	EF	Exposure Frequency	days/year	250	U.S. EPA, May 1993	219	U.S. EPA, May 1993	
	ED	Exposure Duration	years	25	U.S. EPA, May 1993	9	U.S. EPA, May 1993	
	ET	Exposure Time	hr/day	8	U.S. EPA, December 2002	8	Professional judgement	
	BW	Body Weight	kg	70	U.S. EPA, December 1989	70	U.S. EPA, December 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	9,125	U.S. EPA, December 1989	3,285	U.S. EPA, December 1989	

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

**SITE 22 - TABLE 9**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF FUTURE ADULT RESIDENTS TO INDOOR AIR  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Soil/Groundwater
Exposure Medium: Air
Exposure Point: Indoor Air
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	CTE Value	CTE Rationale/Reference	Intake Equation/Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	USEPA, December 2000	Derived	USEPA, December 2000	Chronic Daily Intake (CDI) (mg/kg-day)= <u>Cair x IRa x ET x EF x ED</u> BW x AT
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	20	USEPA, August 1997	20	USEPA, August 1997	
	EF	Exposure Frequency	days/year	350	USEPA, May 1993	234	USEPA, May 1993	
	ED	Exposure Duration	years	24	USEPA, May 1993	7	USEPA, May 1993	
	BW	Body Weight	kg	70	USEPA, December 1989	70	USEPA, December 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA, December 1989	25550	USEPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	8,760	USEPA, December 1989	2,555	USEPA, December 1989	

Note: The same exposure parameters are used for civilian and military adult residents, with the exception of exposure duration (ED).

Adult Military residents are assumed to be exposed for a period of 6 years for the RME and CTE.

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

**SITE 22 - TABLE 10**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF FUTURE CHILD RESIDENTS TO INDOOR AIR  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future  
Medium: Soil/Groundwater  
Exposure Medium: Air  
Exposure Point: Indoor Air  
Receptor Population: Resident  
Receptor Age: Child (0-6 Years)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	CTE Value	CTE Rationale/Reference	Intake Equation/Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	U.S. EPA, December 2000	Derived	U.S. EPA, December 2000	Chronic Daily Intake (CDI) (mg/kg-day)= $C_{air} \times IR_a \times ET \times EF \times ED$ BW x AT
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	10	U.S. EPA, August 1997	10	U.S. EPA, August 1997	
	EF	Exposure Frequency	days/year	350	U.S. EPA, May 1993	234	U.S. EPA, May 1993	
	ED	Exposure Duration	years	6	U.S. EPA, May 1993	2	U.S. EPA, May 1993	
	BW	Body Weight	kg	15	U.S. EPA, May 1993	15	U.S. EPA, May 1993	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	2,190	U.S. EPA, December 1989	730	U.S. EPA, December 1989	

Note: The same exposure parameters are used for civilian and military child residents.

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

**SITE 22 - TABLE 11**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF FUTURE ADULT RESIDENTS TO VAPORS FROM GROUNDWATER WHILE SHOWERING  
SITE 22 - BUILDING 105  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future  
Medium: Groundwater  
Exposure Medium: Groundwater  
Exposure Point: Tap Water  
Receptor Population: Resident  
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Inhalation	S	Volatile Chemical Generation Rate	ug/m <sup>3</sup> -min shower	Derived	Foster&Chrostowski , 1987	Derived	Foster&Chrostowski , 1987	Chronic Daily intake (CDI) (mg/kg-day)= $S \times IR_{sh} \times K \times EF \times ED$ $BW \times AT \times Ra \times CF$ $K = Ds + \exp(-Ra \times Dt)/Ra - (\exp(Ra) \times (Ds-Dt))/Ra$
	IRsh	Inhalation Rate of Volatiles in Showe	L/min	10	U.S. EPA, December 1989	10	U.S. EPA, December 1989	
	EF	Exposure Frequency	days/year	350	U.S. EPA, May 1993	234	U.S. EPA, May 1993	
	K	Masss Transfer Coefficient	min	Derived	Foster&Chrostowski , 1987	Derived	Foster&Chrostowski , 1987	
	ED	Exposure Duration	years	24	U.S. EPA, May 1993	7	U.S. EPA, May 1993	
	BW	Body Weight	kg	70	U.S. EPA, May 1993	70	U.S. EPA, May 1993	
	Ra	Air Exchange Rate	min <sup>-1</sup>	0.0167	Foster&Chrostowski , 1987	0.0167	Foster&Chrostowski , 1987	
	Ds	Shower Duration	min	15	U.S. EPA, September 2001	10	U.S. EPA, September 2001	
	Dt	Total Time in Bathroom	min	20	Professional judgement	15	Professional Judgement	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	8,760	U.S. EPA, December 1989	2,555	U.S. EPA, December 1989	

RME = Reasonable Maximum Exposure  
CTE = Central Tendency Exposure

**SITE 22 - TABLE 12**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF FUTURE CHILD RESIDENTS TO VAPORS FROM GROUNDWATER WHILE SHOWERING  
SITE 22 - BUILDING 105  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Tap Water
Receptor Population: Resident
Receptor Age: Child (0 to 6 years)

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Inhalation	S	Volatile Chemical Generation Rate	ug/m <sup>3</sup> -min shower	Derived	Foster&Chrostowski , 1987	Derived	Foster&Chrostowski , 1987	Chronic Daily Intake (CDI) (mg/kg-day)= $S \times IR_{sh} \times K \times EF \times ED$ $BW \times AT \times Ra \times CF$ $K = Ds + \exp(-Ra \times Dt)/Ra - [\exp(Ra) \times (Ds-Dt)]/Ra$
	IRsh	Inhalation Rate of Volatiles in Shower	L/min	10	U.S. EPA, December 1989	10	U.S. EPA, December 1989	
	EF	Exposure Frequency	days/year	350	U.S. EPA, May 1993	234	U.S. EPA, May 1993	
	K	Mass Transfer Coefficient	min	Derived	Foster&Chrostowski , 1987	Derived	Foster&Chrostowski , 1987	
	ED	Exposure Duration	years	6	U.S. EPA, May 1993	2	U.S. EPA, May 1993	
	BW	Body Weight	kg	15	U.S. EPA, May 1993	15	U.S. EPA, May 1993	
	Ra	Air Exchange Rate	min <sup>-1</sup>	0.0167	Foster&Chrostowski , 1987	0.0167	Foster&Chrostowski , 1987	
	Ds	Shower Duration	min	15	U.S. EPA, September 2001	10	U.S. EPA, September 2001	
	Dt	Total Time in Bathroom	min	20	Professional judgement	15	Professional judgement	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	2,190	U.S. EPA, December 1989	730	U.S. EPA, December 1989	

RME = Reasonable Maximum Exposure

CTE = Central Tendency Exposure

**SITE 22 - TABLE 13**

**VALUES USED FOR DAILY INTAKE CALCULATIONS  
EXPOSURE OF CONSTRUCTION WORKERS TO AIR IN A TRENCH  
SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY  
NTC, GREAT LAKES, ILLINOIS**

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Trench (<15 feet deep)
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CTE Value	CTE Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Cair	Chemical Concentration in Air	mg/m <sup>3</sup>	Derived	VDEQ, August 2002	Derived	VDEQ, August 2002	Chronic Daily Intake (CDI) (mg/kg-day)= <u>Cair x IRa x ET x EF x ED</u> BW x AT
	IRa	Inhalation Rate of Volatiles	m <sup>3</sup> /hr	2.5	U.S. EPA, December 2002	2.5	U.S. EPA, December 2002	
	EF	Exposure Frequency	days/year	150	Professional Judgement. Ground assumed to be frozen 22 weeks/yr.	150	Professional Judgement. Ground assumed to be frozen 22 weeks/yr.	
	ED	Exposure Duration	years	1	U.S. EPA, May 1993	1	U.S. EPA, May 1993	
	ET	Exposure Time	hr/day	4	Professional judgement	2	Professional Judgement	
	BW	Body Weight	kg	70	U.S. EPA, December 1989	70	U.S. EPA, December 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	U.S. EPA, December 1989	25,550	U.S. EPA, December 1989	
	AT-N	Averaging Time (Noncancer)	days	365	U.S. EPA, December 1989	365	U.S. EPA, December 1989	

RME = Reasonable Maximum Exposure  
CTE = Central Tendency Exposure

## **APPENDIX V**

### **SUPPLEMENTAL FIELD SAMPLING PLAN AND FIELD STANDARD OPERATING PROCEDURES**



**Supplemental Field Sampling Plan  
for  
Remedial Investigation &  
Risk Assessment  
at  
Site 22 – Building 105 Old Dry Cleaning  
Facility**

**Naval Training Center  
Great Lakes**  
Great Lakes, Illinois



**Southern Division  
Naval Facilities Engineering Command**  
Contract Number N62467-94-D-0888  
Contract Task Order 0154/290

April 2003

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### APPENDICES

- A FIELD FORMS**
- B STANDARD OPERATING PROCEDURES**
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## 1.0 INTRODUCTION

### 1.1 INTRODUCTION

This Supplemental Field Sampling Plan (FSP) is an addendum to the existing FSP (Appendix V) and existing Quality Assurance Project Plan (QAPP) (TtNUS, 2001) for Naval Training Center (NTC) Great Lakes and describes the sampling and analysis procedures to be used for Site 22 - Building 105 Old Dry Cleaning Facility during Remedial Investigation/Risk Assessment activities. The investigation at Site 22 will be similar to the investigation at Site 7. Changes to the existing FSP and QAPP are noted in the text below. Tetra Tech NUS, Inc. (TtNUS) will conduct these activities under the Comprehensive Long-Term Environmental Action, Navy (CLEAN) Contract Number N62467-94-D-0888, in accordance with the Statement of Work for Contract Task Order (CTO) 290 at the NTC Great Lakes and the Guidance for Conducting Remedial Investigations and Feasibility Studies under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (U.S. EPA, 1988).

The field investigation at Site 22, NTC Great Lakes will consist of the tasks below. The majority of these tasks are described in the QAPP and FSP (TtNUS, 2001). The following section describes those activities that will be conducted that are not discussed in the QAPP and FSP (TtNUS, 2001).

- Mobilization/demobilization
- Field equipment maintenance
- Drilling
  - Installation of soil borings
  - Installation of permanent monitoring wells
- Soil sampling
  - Surface soil sampling
  - Subsurface soil sampling
- Groundwater sampling
  - Monitoring wells
- Equipment decontamination
- Aquifer testing
- Groundwater level measurements
- Investigation-derived waste (IDW) handling and disposal
- Site restoration
- Land surveying of sample locations

## **2.0 FIELD OPERATIONS**

### **2.1.2 Site Restoration**

Site restoration will also include replacing asphalt and the subsurface high density polyethylene (HDPE) liner at soil boring and monitoring well locations.

### **2.3.3 Monitoring Well Protection**

Surrounding the monitoring well a flush-mounted cover and vault will be installed in a 2 foot by 2 foot by 6 inch thick concrete pad. The flush-mounted concrete pads/casings will be completed level with existing grade.

### **2.4.1 Groundwater Sampling**

Groundwater samples will be collected from the 9 newly installed monitoring wells at Site 22 and submitted for fixed-based laboratory analyses. Sampling for natural attenuation parameters will also be performed at selected wells.

## **2.9 FIELD MEASUREMENTS**

Field measurements for the purposes of the natural attenuation analysis will be conducted using field test kits provided by HACH and CHEMetrics and will be recorded during field sampling operations. These field test kits include alkalinity, ferrous iron, manganese, carbon dioxide, dissolved oxygen, hydrogen sulfide, and sulfide.

SOP CTO 290-1 and the associated field sample logsheets provide additional details concerning the field natural attenuation analyses. Analyses using the field test kits will be conducted in accordance with the manufacturer's instructions.

### **3.0 SITE-SPECIFIC FIELD SAMPLING PLANS**

#### **3.3 SITE 22 - BUILDING 105 OLD DRY CLEANING FACILITY**

Background information about Site 22 - Building 105 Old Dry Cleaning Facility, including a site description and summary of previous investigations, can be found in Section A5 of the QAPP addendum. A detailed description of the proposed investigation for Site 22 is included in Section B2 of the QAPP addendum. The objectives of the proposed investigation are as follows:

- To determine human health and ecological risks for potential receptors exposed to site media under current and future land use scenarios.
- To delineate soil and groundwater contamination resulting from the site activities.

Figures B-4 and B-5 in the QAPP shows proposed sampling locations, and Tables B-23 through B-27 in the QAPP summarize the samples that will be collected at Site 22. Sample containers, preservation requirements, and holding times are provided in Tables B-10 and B-11.

## **APPENDIX A**

### **FIELD FORMS**



# FIELD ANALYTICAL LOG SHEET GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

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Project Site Name: NTC Great Lakes Site 22

Sample ID No.:                     

Project No.: N1474 CTO 290

Sample Location:                     Sampled By:                     Duplicate: ☐Field Analyst:                     Blank: ☐Field Form Checked (initials):                     **SAMPLING DATA:**

Date:	Color	ORP (Eh)	S.C.	Temp.	Turbidity	DO	Sal.	pH
Time:	(Visual)	(+/- mv)	(mS/cm)	(°C)	(NTU)	(Meter, mg/l)	(‰)	(SU)
Method:								

**SAMPLE COLLECTION/ANALYSIS INFORMATION:****Dissolved Oxygen:**

Equipment: HACH Digital Titrator OX-DT

CHEMetrics (Range:          mg/L)Analysis Time:                     

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
<input type="checkbox"/>	1-5 mg/L	200 ml	0.200 N	0.01
<input type="checkbox"/>	2-10 mg/L	100 ml	0.200 N	0.02

Titration Count	Multiplier	Concentration
<u>        </u>	x 0.01	=
<u>        </u>	x 0.02	=

CHEMetrics:          mg/LNotes:                                     **Alkalinity:**Analysis Time:                     

Equipment: HACH Digital Titrator AL-DT

CHEMetrics (Range:          mg/L)Filtered: ☐

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
<input type="checkbox"/>	10-40 mg/L	100 ml	0.1600 N	0.1	<u>        </u> & <u>        </u>	x 0.1	=
<input type="checkbox"/>	40-160 mg/L	25 ml	0.1600 N	0.4	<u>        </u> & <u>        </u>	x 0.4	=
<input type="checkbox"/>	100-400 mg/L	100 ml	1.600 N	1.0	<u>        </u> & <u>        </u>	x 1.0	=
<input type="checkbox"/>	200-800 mg/L	50 ml	1.600 N	2.0	<u>        </u> & <u>        </u>	x 2.0	=
<input type="checkbox"/>	500-2000 mg/L	20 ml	1.600 N	5.0	<u>        </u> & <u>        </u>	x 5.0	=
<input type="checkbox"/>	1000-4000 mg/L	10 ml	1.600 N	10.0	<u>        </u> & <u>        </u>	x 10.0	=

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

CHEMetrics:          mg/LNotes:                                     Standard Additions: ☐ Titrant Molarity:          Digits Required: 1st.:          2nd.:          3rd.:         **Carbon Dioxide:**

Equipment: HACH Digital Titrator CA-DT

CHEMetrics (Range:          mg/L)Analysis Time:                     

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
<input type="checkbox"/>	10-50 mg/L	200 ml	0.3636 N	0.1
<input type="checkbox"/>	20-100 mg/L	100 ml	0.3636 N	0.2
<input type="checkbox"/>	100-400 mg/L	200 ml	3.636 N	1.0
<input type="checkbox"/>	200-1000 mg/L	100 ml	3.636 N	2.0

Titration Count	Multiplier	Concentration
<u>        </u>	x 0.1	=
<u>        </u>	x 0.2	=
<u>        </u>	x 1.0	=
<u>        </u>	x 2.0	=

CHEMetrics:          mg/LNotes:                                     Standard Additions: ☐ Titrant Molarity:          Digits Required: 1st.:          2nd.:          3rd.:



# FIELD ANALYTICAL LOG SHEET GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

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Project Site Name: NTC Great Lakes Site 22

Sample ID No.:                     

Project No.: N1474 CTO 290

Sample Location:                     

Sampled By:                     

Duplicate: ☐

Field Analyst:                     

Blank: ☐

Field Form Checked (initials):                     

## SAMPLE COLLECTION/ANALYSIS INFORMATION:

### Sulfide ( $S^{2-}$ ):

Equipment: DR-700 DR-8    HS-C Color Chart HS-WR Color Wheel Analysis Time:                     

Program/Module: 610nm 93 Other:                     

Concentration:                      mg/L Filtered: ☐

Notes:                     

### Sulfate ( $SO_4^{2-}$ ):

Equipment: DR-700 DR-8    Other:                      Analysis Time:                     

Program/Module: 91

Concentration:                      mg/L Filtered: ☐

Standard Solution: ☐ Results:                     

Standard Additions: ☐ Digits Required: 0.1ml:            0.2ml:            0.3ml:           

Notes:                     

### Nitrite ( $NO_2^-$ -N):

Analysis Time:                     

Equipment: DR-700 DR-8    Other:                      Filtered: ☐

Program/Module: 60

Concentration:                      mg/L Reagent Blank Correction: ☐

Standard Solution: ☐ Results: ☐

Notes:                     

### Nitrate ( $NO_3^-$ -N):

Analysis Time:                     

Equipment: DR-700 DR-8    Other:                      Filtered: ☐

Program/Module: 55

Concentration:                      mg/L

Nitrite Interference Treatment: ☐

Standard Solution: ☐ Results:                     

Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:            0.2ml:            0.3ml:           

Notes:





## **APPENDIX B**

### **STANDARD OPERATING PROCEDURES**

## STANDARD OPERATING PROCEDURE

### SOP CTO 290-1

## NATURAL ATTENUATION PARAMETER COLLECTION

### 1.0 PURPOSE

The purpose of this document is to provide general reference information regarding natural attenuation parameter and methodology selection, sample collection, and a general understanding of the sample results.

### 2.0 SCOPE

This document provides information on selection of appropriate groundwater natural attenuation parameters, selection of sampling methods for these parameters, techniques for onsite field analysis of select parameters, and some basic understanding of the field sample results. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling practices and techniques. To a limited extent, it shall also facilitate the understanding and interpretation of the sampling results. It addresses field procedures for collection of data at sites with organic groundwater contaminants (e.g., chlorinated and petroleum hydrocarbons) to the extent practical. The focus of this document is on natural attenuation, not enhanced bioremediation.

The techniques described shall be followed whenever applicable, noting that site-specific conditions, project-specific objectives, local, state, and federal guidelines may be used as a basis for modification of the procedures noted herein. The intent of this document is to supplement the local, state, and federal guidance documents and manufacturer's analytical methods referenced in Section 6.0. It is not intended for this document to supersede this guidance or information. Please note that natural attenuation is a relatively dynamic science with ongoing research in the science and engineering community. It is important that data collectors and interpreters use the most recent regulatory guidance, which may be updated on a periodic basis from that noted in Section 6.

### 3.0 GLOSSARY

*Aerobe*: Bacteria that use oxygen as an electron acceptor.

*Anaerobe*: Organisms that can use electron acceptors other than molecular oxygen to support their metabolism.

*Anoxic groundwater*: Groundwater that contains oxygen in concentrations less than about 0.5 mg/L. This term is synonymous with the term anaerobic.

*Anthropogenic*: Man-made.

*Cometabolism*: The process in which a compound is fortuitously degraded by an enzyme or cofactor produced during microbial metabolism of another compound.

*Daughter product*: A compound that results directly from the biotic or abiotic degradation of another. For example, *cis*-1,2-dichloroethene (*cis*-1,2-DCE) is a common daughter product of trichloroethene (TCE).

*Diffusion*: The process whereby molecules move from a region of higher concentration to a region of lower concentration as a result of Brownian motion.

*Dispersion*: The tendency for a solute to spread from the path that it would be expected to follow under advective transport.

*Electron acceptor:* A compound capable of accepting electrons during oxidation-reduction reactions. Microorganisms obtain energy by transferring electrons from an electron donor such as an organic compound (or sometimes a reduced inorganic compound such as sulfide) to an electron acceptor. Electron acceptors are compounds that are relatively oxidized and include oxygen, nitrate, iron(III), manganese(IV), sulfate, carbon dioxide, or in some cases chlorinated aliphatic hydrocarbons such as tetrachloroethene (PCE), TCE, DCE and vinyl chloride (VC).

*Electron donor:* A compound capable of supplying (giving up) electrons during oxidation-reduction reactions. Microorganisms obtain energy by transferring electrons from an electron donor such as an organic compound (or sometimes a reduced inorganic compound such as sulfide) to an electron acceptor. Electron donors are compounds that are relatively reduced and include fuel hydrocarbons and native organic carbon.

*Metabolic byproduct:* A product of the reaction between an electron donor and an electron acceptor. Metabolic byproducts include volatile fatty acids, daughter products of chlorinated aliphatic hydrocarbons, methane, and chloride.

*Oxic groundwater:* Groundwater that contains oxygen in concentrations greater than about 0.5 mg/L.

*Oxidation/reduction reaction:* A chemical or biological reaction wherein an electron is transferred from an electron donor (donor is oxidized) to an electron acceptor (acceptor is reduced).

*Predominant terminal electron-accepting process:* The electron-accepting process (oxygen reduction, nitrate reduction, iron(III) reduction, etc.) that sequesters the majority of the electron flow in a given system.

*Reductive dechlorination:* Reduction of a chlorine-containing organic compound via the replacement of chlorine with hydrogen.

*Respiration:* The process of coupling the oxidation of organic compounds with the reduction of inorganic compounds such as oxygen, nitrate, iron(III), manganese(IV), and sulfate.

*Seepage velocity:* The average velocity of groundwater in a porous medium.

*Substrate:* A compound used by microorganisms to obtain energy for growth. The term can refer to either an electron acceptor or an electron donor.

#### 4.0 RESPONSIBILITIES

Project Manager (PM) / Task Order Manager (TOM) - Responsible for ensuring that field activities are conducted in accordance with this standard operating procedure (SOP).

Project Hydrogeologist or Geochemist - Responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), and equipment to be used, and providing detailed input in this regard to the project plan documents. The project hydrogeologist or geochemist is also responsible for properly briefing and overseeing the performance of the site sampling personnel.

Site Manager (SM) / Field Operations Leader (FOL) - Responsible for the onsite verification that the field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Project Geologist - is primarily responsible for the proper acquisition of the groundwater samples. He/she is also responsible for the actual analyses of onsite water quality samples, as well as instrument calibration, care, and maintenance. When appropriate, such responsibilities may be performed by other qualified personnel (e.g., field sampling technicians or site personnel).

## 5.0 PROCEDURES

### 5.1 General

Natural attenuation includes physical, chemical, and biochemical processes affecting the concentrations of dissolved contaminants in groundwater. These processes may include advection, dispersion, volatilization, dilution, sorption to aquifer solids, and/or precipitation or mineralization of compounds. Of greatest importance are those processes that lead to a reduction in contaminant mass (by degrading or destroying contaminants) such as biodegradation. These biochemical processes remove organic contaminants from the aquifer by destruction. Depending on the type of contaminant, particularly the organic contaminant (e.g., petroleum hydrocarbons or chlorinated organic solvents), the biochemical environment in the aquifer will vary. The biochemical environment within the aquifer influences and is influenced by the activities of aquifer microbiota. Specific types of microbiota, working singly or in complex consortia, may use organic contaminants as part of their normal cell functions. Natural attenuation monitoring is designed to measure indicators of the biochemical environment within the aquifer and, with direct and indirect lines of evidence and associated chemical concentration data, evaluate the likely fate (i.e., transformation, destruction, dilution, attenuation, etc.) of organic contaminants.

### 5.2 Planning for Natural Attenuation Sampling

The first step in preparing a natural attenuation investigation is to develop a site-specific conceptual model. The first step in development of this model is the analysis and review of available site-specific characterization data. The development and refinement of this model should be supplemented with additional data as needed. The data should include but is not limited to:

- Geologic and hydrogeologic information in three dimensions
- Nature, extent, and magnitude of contamination
- Location and presence of potential receptors to contamination

#### **Lines of Evidence**

Several lines of evidence are used to determine whether natural attenuation is working. The most compelling, primary evidence is decreasing groundwater contaminant concentrations over time. Decreasing concentration trends can be demonstrated in several ways including:

- Isoconcentration maps of the dissolved plume over time wherein the extent of the plume is either stable or decreasing.
- Time series plots of contaminant concentrations within a well illustrating a clear downward trend.
- Contaminant concentration profiles in a series of monitoring wells along a groundwater flow path illustrating decreasing concentrations beyond that attributable to dilution and dispersion.

Secondary, or supporting, lines of evidence include:

- Analytical data showing production and subsequent destruction of primary contaminant breakdown products.
- Geochemical data indicating that the biochemical environment is favorable for the appropriate microbiota.

- Geochemical data that indicate the aquifer microbiota are active.

### **Monitoring Well Location and Sampling Frequency**

The number and locations of wells required to monitor natural attenuation will depend on the physical setting at each location. One possible array of monitoring wells is illustrated in Attachment A. In this scenario, one well is used to monitor conditions upgradient of the source, one well is located in the source area, and several wells are used to define and monitor the downgradient and lateral extent of the dissolved plume. At a minimum, there should be at least one upgradient well (ideally with no contamination present), one well in the source area, one well downgradient from the source area in the dissolved plume, and one downgradient well where contaminant concentrations are below regulatory criteria. Note that the number and locations of monitoring wells will vary depending on the site complexity and site objectives.

Sampling frequency will be dictated by the ultimate use of the data and site-specific characteristics. Contaminant concentrations may be used to define statistically meaningful trends in contaminant concentrations. The sampling frequency may be defined by the hydrogeologic and/or geochemical conditions as well as the proposed statistical method for data analysis. For example, groundwater flow and contaminant characteristics (e.g., seepage velocity and contaminant loading) may dictate the sample frequency. Regardless of the factors, sampling frequency and duration will need to establish the range of natural chemical variability within the aquifer. After a sufficient amount of data has been collected and the geochemical conditions are understood, the frequency of sampling may be reduced. See Section 5.4 for additional information on sample collection and frequency.

### **5.3 Selection of Natural Attenuation Parameters**

Natural attenuation via biodegradation depends on the nature of the organic contaminants and the oxidation-reduction (redox) environment within the aquifer. Simply stated, if the contaminants are fuels, biodegradation will be most effective if the redox conditions are aerobic or oxidizing. If the contaminants are chlorinated solvents, the biodegradation will be most effective (in the source and near source areas) if redox conditions in the aquifer are anaerobic or reducing.

Several parameters are needed to evaluate whether natural attenuation is taking place and, if so, the rate at which it may be occurring. The primary parameter providing direct evidence of natural attenuation is the aqueous concentrations of parent and daughter volatile organic compounds. More specifically, a decrease in parent products, an increase in daughter products, evidence that the plume is stable or shrinking in size, and overall decline in contaminant concentrations is direct evidence of natural attenuation. Natural attenuation or geochemical parameters that provide information about the redox conditions in the aquifer include:

- Dissolved oxygen
- Nitrate/nitrite
- Dissolved manganese
- Iron
- Sulfate/sulfide
- Methane
- Oxidation-reduction potential (ORP)

Secondary parameters that indicate biological activity in the aquifer and thereby support the natural attenuation evaluation include:

- Dissolved hydrogen
- Alkalinity
- Dissolved carbon dioxide

The concentrations of natural attenuation parameters are used to define the aquifer redox conditions. It is important to record and document the presence or absence (i.e., measurable or not measurable concentration) of certain natural attenuation parameters. The presence or absence of a certain substance may be sufficient to indicate the redox condition within the aquifer. By reference to Attachment B, which illustrates the typical sequence of biologically mediated redox reactions in natural systems, it is apparent that, for example, sulfate reduction (producing dissolved sulfide in groundwater) does not operate in an aerobic environment. Therefore, measurable sulfide should not be present if there is also dissolved oxygen at concentrations indicating an aerobic environment. Attachment B also illustrates the redox potential (measured in millivolts) associated with the redox reactions. ORP readings, also in millivolts, measured during well purging, may be compared with the range of values in Attachment B but with caution. Redox potentials measured with a platinum electrode in natural water samples may be misleading, especially when biologically mediated reactions are important, because many of the critical reactions in Attachment B do not generate a response in the electrode. Dissolved hydrogen concentration ranges associated with important redox reactions are also indicated in Attachment B. Because dissolved hydrogen is actually used by microbiota during redox reactions, its concentration may provide an additional indicator of the overall redox condition in the aquifer.

Attachments C and D tabulate the natural attenuation parameters for chlorinated volatile organic compound and petroleum hydrocarbon plumes, respectively. The parameters listed in these tables are organized in order of importance. Parameters selected for analysis shall be determined based on site conditions, project-specific plans, and/or other criteria established for the project. Based on these criteria, it is possible that all of the parameters may be selected.

#### **5.4      Selection of Natural Attenuation Analytical Methods and Procedures**

There are many analytical methods available to measure concentrations of the natural attenuation parameters discussed in the previous sections. Attachment E summarizes the sample methodologies, sampling equipment needed, sample volume, container, preservation, and holding time requirements. This table also summarizes the detection limits and the detection ranges for each method. A number of factors should be considered when selecting the appropriate sample analytical methodology including the required parameters, appropriate detection ranges for each compound, cost, and ease of use in the field. For example, when determining the correct methodology for measuring concentrations of total sulfide, the metabolic byproduct of sulfate reducing conditions, it is important to analyze for each of the forms of sulfide ( $\text{H}_2\text{S}$ ,  $\text{S}^{2-}$ , and  $\text{HS}^-$ ). Also, when the detection limit of the selected method is exceeded, another method may be considered, or the sampler may be able to dilute the sample (per manufacturer's instructions) to quantify it within the detected range. In terms of cost, some parameters are very time consuming when performed in the field. Without sacrificing sample integrity it may be more appropriate to select a methodology performed in a fixed-base laboratory. Finally, in terms of ease of use, certain field methods are generally easier compared to other methods. Using simpler methods may result in better quality sample results and increased sample repeatability without sacrificing sample integrity. For example, in some cases CHEMetrics Titret® Titration Ampule kits may be a good alternative to other hand digital titration methods.

The sample technicians should be aware that based on geochemical conditions recorded in the field, certain geochemical parameters may not have positive detections. For example, if dissolved oxygen concentrations indicate aerobic conditions then it is unlikely that dissolved hydrogen is present (see Section 5.10 for additional information). Another example is alkalinity. If the pH of the groundwater

sample is less than 4.5, then it is unlikely that alkalinity will be measurable. Despite the potential for non-detect results, in cases such as those described above, the parameters should be collected in the field based upon project plans. The value in collecting the parameters in the future shall be determined by the project hydrogeologist and/or geochemist in accordance with the projects planning documents data quality objectives (DQO) and the items discussed in Section 5.2.

## **5.5      Procedures for Sample Collection**

Groundwater sample collection for natural attenuation sampling should be performed using low flow purging and sampling techniques. Low flow purging and sampling procedures should be used to ensure the collection of a sample that is "representative" of the water present in the aquifer formation. Minimizing stress on the aquifer formation during low flow purging and sample collection ensures that there are minimal alternations to the water chemistry of the sample. The criteria used in the purging process should include minimization of drawdown in the well, stabilization of applicable indicator parameters, and evacuation of a sufficient amount of purge volume in accordance project plans and/or applicable regulatory guidance.

Groundwater purging and sampling for natural attenuation should be performed using submersible pumps (e.g., bladder pumps). However, in accordance with project plans and applicable regulatory guidance, peristaltic pumps may also be used for this purpose. Limitations of and factors associated with using these devices should be considered. As a result of difficulties in collecting "representative" groundwater samples, bailers should not be used for the collection of natural attenuation samples.

It is critical that disturbance and aeration of samples monitored and collected at the well head are minimized. As a result, a flow-through sampling cell and a direct reading meter shall be used for the measurement of well stabilization indicator parameters (e.g., pH, conductivity, temperature, dissolved oxygen, turbidity, and ORP) at the well head. The pump effluent tubing should be placed at the bottom of the flow-through cell allowing effluent water from the cell to discharge at the top of the meter (above the detector probes) to minimize the agitation of water in the cell.

Documentation of the purging process shall be recorded during and at the completion of purging as discussed in Section 5.8. Immediately following the purging process and before sampling, applicable indicator parameters must be measured and recorded on the appropriate sample log sheets as discussed in Section 5.8.

After the purging requirements have been met, groundwater sampling and natural attenuation data collection can begin. Monitoring wells will be sampled using the same pump and tubing used during well purging.

## **5.6      Procedures for Field Sample Analysis**

Each of the field and fixed-base laboratory sample parameters requires different sampling procedures and holding times. Attachment E presents parameter-specific requirements for sampling, analysis, and storage of the parameters and methods sampled as part of natural attenuation analysis.

Due to parameter procedure and holding times, it is important to consider the sequence of sample collection and analysis. Generally speaking, with the exception of volatile organic compounds, field parameters shall be analyzed first followed by fixed-base laboratory sample collection. Samples will be collected in a sequence and manner that minimizes volatilization, oxidation, and/or chemical transformation of compounds. As a result, the following sample and analysis order should be followed:



- |  |                                    |
|--|------------------------------------|
| 1. Volatile organic compounds                      | 8. Nitrate / Nitrite               |
| 2. Dissolved oxygen                                | 9. Dissolved manganese             |
| 3. Alkalinity                                      | 10. Semivolatile organic compounds |
| 4. Dissolved carbon dioxide                        | 11. Other dissolved metals         |
| 5. Dissolved ferrous iron                          | 12. Total metals                   |
| 6. Dissolved sulfide (hydrogen sulfide, sulfide)   | 13. Other constituents             |
| 7. Dissolved hydrogen, methane, ethene, and ethane |                                    |

Field-analyzed parameters should be collected and immediately analyzed directly from the pump effluent per the requirements on Attachment E and manufacturer's recommendations. Care should be taken to minimize any unnecessary disturbance, aeration, or agitation of the sample prior to analysis. It is not acceptable to collect and store samples that are to be analyzed immediately at the well head in a temporary holding container (e.g., open topped pitcher) to be analyzed at a later time.

The manufacturer's procedure manual for each of the field-based analyses shall be maintained in the field during the entire sampling program. The procedures give a detailed explanation of how to perform each particular method and include information on sampling, storage, accuracy checks, interferences, reagents, and apparatus needed to perform each analysis.

#### 5.7 Procedures for Quality Assurance and Quality Control Field Sample Analysis

Accuracy and precision checks shall be performed to check the performance of the reagents, apparatus, and field analytical procedures per the manufacturer's recommendations. The accuracy checks should include the use of standard solutions (i.e., standard addition), as appropriate. The manufacturer's field test kit manual provides details on how to perform each of the accuracy checks for each parameter where applicable. Refer to Section 6.0 for manufacturer contact information.

Precision checks must include the performance of duplicate analysis. When using a colorimeter, precision checks may also include reagent blank corrections and standard curve adjustments as recommended by the manufacturer. Field duplicate results shall be performed and evaluated for relative percent difference (RPD) at a rate of 1 per 10 samples or as determined by the project plans. The RPD can be calculated as follows:

$$RPD = \left| \frac{\text{First result} - \text{Second result}}{\text{Mean arithmetic (average) of first and second result}} \right| \times 100$$

If the RPD exceeds 50 percent, it is required that the test be performed again to verify the result. The duplicate results shall be documented in the 'Notes' section for that specific parameter on the appropriate sample logsheet (see Section 5.8).

If a colorimeter (e.g., HACH DR-890 or equivalent) is used for parameter analysis, an instrument performance verification test using absorbance standards may also be performed to ensure the meter is providing accurate measurements.

The following table lists examples of the types and frequencies of accuracy checks required for each parameter. Refer to the manufacturer's instructions for information regarding other analyses.

Parameter	Method	Standard Solution	Field Duplicate	Reagent Blank Correction
-----------	--------	-------------------	-----------------	--------------------------

Alkalinity	CHEMetrics K-9810, -15, -20	None	1 per 10	None
Carbon dioxide	CHEMetrics K-1910, -20, -25	None	1 per 10	None
Dissolved oxygen	CHEMetrics K-7501, -12	None	1 per 10	None
Ferrous iron	HACH DR-890	None	1 per 10	None
Nitrite	HACH DR-890	1 per round	1 per 10	1 per lot
Nitrate	HACH DR-890	1 per round	1 per 10	1 per lot
Sulfide	HACH DR-890	None	1 per 10	None
Hydrogen sulfide	HACH HS-C	None	1 per 10	None

Prior to analysis, the expiration dates of reagents shall be checked. If the reagents have exceeded their expiration date or shelf life, the reagents shall be replaced. If deviations from the applicable analytical procedure are identified, the deviations shall be corrected and the associated samples re-analyzed. If problems are identified with the reagents, apparatus, or procedures, data interferences may be present. Interferences may also be due to other factors (e.g., pH, presence or concentration of other ions, turbidity, temperature, etc.) that may interfere with the sample result. The manufacturer's procedures (e.g., Hach, 1999) should be reviewed prior to analysis to avoid or minimize such interferences. Associated problems or suspected interferences shall be documented in the 'Notes' section of the sample logsheet. Often, interferences cannot be avoided. In these cases, the sampler should be aware of these potential interferences and document them properly.

#### **5.8 Documentation Procedures for Field Sample Analysis**

Field results shall be properly documented in the field. The sample log sheet titled "Field Analytical Log Sheet, Geochemical Parameters" shall be prepared for each sample collected and analyzed in the field. Other field log sheets (e.g., low flow purge log sheet, groundwater sample logsheet, etc.) shall also be completed.

Specific information shall also be recorded in the project logbook. This information shall include, but is not limited to, the test kit name and model number, lot number and expiration date of the test kit and reagents used, serial number of the instrument (e.g., colorimeter) used for the analysis, and results of the quality assurance and quality control field sample analysis. Because environmental conditions and changes in those conditions may affect the field analytical results, it is important to document the site conditions (weather, temperature, etc.) at the time of sampling in the logbook.

#### **5.9 Waste Handling and Disposal**

Several of the test kits listed in Attachment E require the use of chemicals and materials that must be properly handled and disposed of in a proper and responsible manner. Refer to the handling and disposal practices and the specific manufacturer's guidance listed in Section 6.0 for more detailed and complete information. Handling and disposal of these items should be conducted in accordance with local, state, and federal guidelines.

## 5.10 Understanding Field Sample Analytical Results

Natural attenuation data interpretation is complicated by the complex inter-relationships of various parameters. The complexity reflects the myriad of biochemical processes. Real-time evaluation of field analytical data can be misleading because a full interpretation often requires combining the field analytical results with fixed-base laboratory results. Regardless, some simple observations and data interpretations in the field may provide insights about the monitoring system or early warnings about sample collection and handling problems.

Data collected from the designated upgradient monitoring well is the baseline from which other interpretations are made. Field analytical data will indicate that the upgradient environment is either oxidizing or reducing. The redox condition within the upgradient area of the aquifer may be natural or impacted by other contaminant source areas (see Section 5.2 for upgradient well selection). Regardless, the redox condition of the upgradient groundwater will influence the source area. Changes in field analytical results from the upgradient well to the source area well will be reflected in samples from monitoring wells further downgradient.

The general characteristics of the two redox environments are summarized in the following table.

<b>Aerobic/Oxidizing</b>	<b>Anaerobic/Reducing</b>
<ul style="list-style-type: none"> <li>• Measurable dissolved oxygen (&gt;1 to 2 ppm)</li> <li>• Measurable nitrate</li> <li>• No measurable dissolved manganese</li> <li>• No measurable dissolved ferrous iron</li> <li>• Measurable dissolved sulfate</li> <li>• No measurable dissolved sulfide</li> <li>• No measurable dissolved methane</li> <li>• No measurable dissolved hydrogen</li> </ul>	<ul style="list-style-type: none"> <li>• No measurable dissolved oxygen (&lt;1 ppm)</li> <li>• No measurable nitrate</li> <li>• Measurable dissolved manganese</li> <li>• Measurable dissolved ferrous iron</li> <li>• No measurable dissolved sulfate</li> <li>• Measurable dissolved sulfide</li> <li>• Measurable dissolved methane</li> <li>• Measurable dissolved hydrogen</li> </ul>

Transitional environments between these two extremes may have intermediate characteristics and are actually quite common. Because reactions are mediated by biological systems, equilibrium (the basis for the figure in Attachment B) conditions within the aquifer should not be expected. For example, sulfate reduction environments may occur in close proximity to methanogenic environments, and this natural attenuation data may be difficult to interpret. Carefully collected and analyzed field measurements and sample collections for fixed-base laboratory analyses are designed to characterize the aquifer environment along the continuum between strongly aerobic and strongly anaerobic. Because the land surface environment is generally more oxidizing than any groundwater environment, sample handling at the point of collection and analysis is extremely important in preserving the chemical integrity of the groundwater sample.

## 6.0 REFERENCES

American Society for Testing and Materials (ASTM), 1998. Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites, Designation: E1943-98, West Conshohocken, Pennsylvania.

Chemetrics, 2002, <http://www.chemetrics.com>.

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USEPA (United States Environmental Protection Agency), 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, EPA/600/R-98/128, Office of Research and Development, Washington, D.C.

Hach Company, 1999. DR-890 Colorimeter Procedures Manual, Product Number 48470-22, Loveland Colorado.

Hach Company, 1999. Digital Titrator (manual), Model Number 16900, Catalog Number 16900-08. Loveland, Colorado.

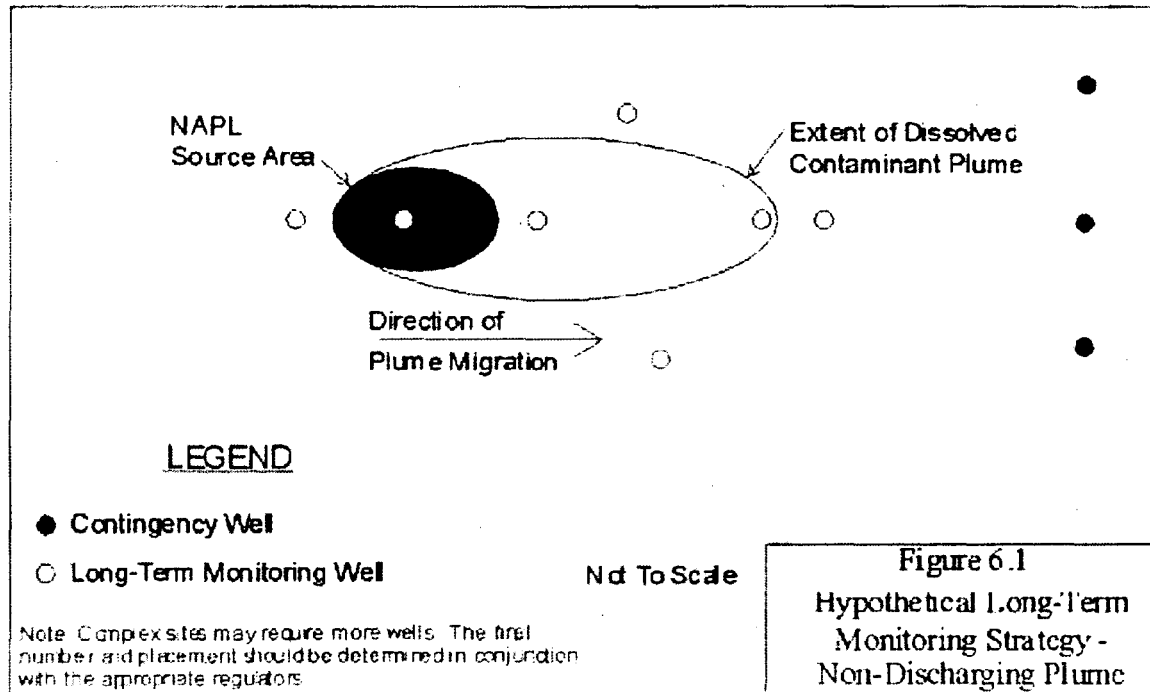
Hach Company, 2002, <http://www.hach.com/>.

USEPA, 1997. Draft EPA Region 4 Suggested Practices for Evaluation of a Site for Natural Attenuation (Biological Degradation) of Chlorinated Solvents; Version 3.0. November.

USEPA, 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, USEPA OSWER Directive 9200.4-17P, April 21, 1999

## ATTACHMENT A

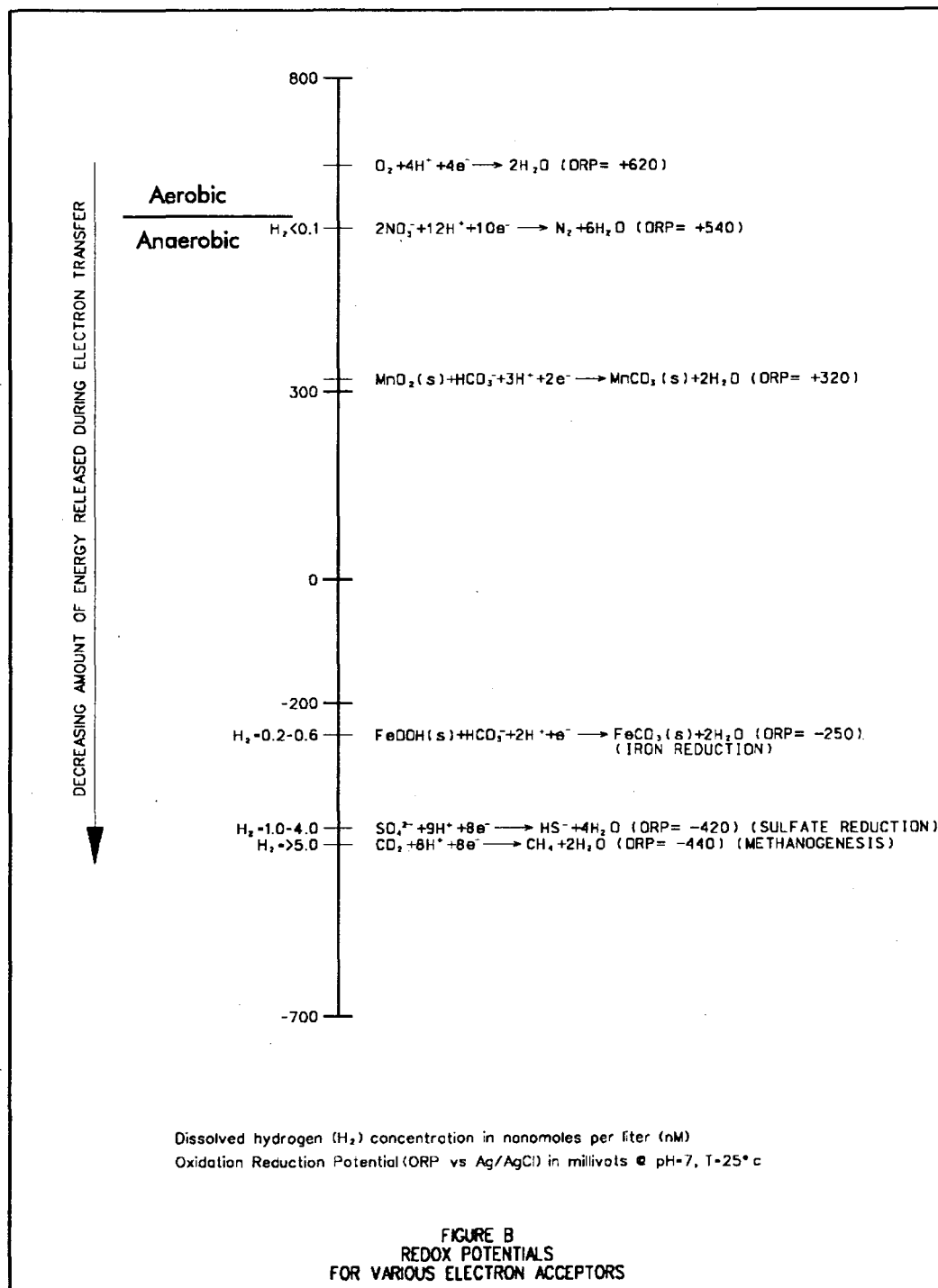
### HYPOTHETICAL LONG-TERM MONITORING STRATEGY



Taken from: Department of the Navy, 1998, Technical Guidelines for Evaluating Monitored Natural Attenuation of Petroleum Hydrocarbons and Chlorinated Solvents in Ground Water at Naval and Marine Corps Facilities, Prepared by Todd Weidemeier and Francis Chappelle.

## ATTACHMENT B

### REDOX POTENTIALS FOR VARIOUS ELECTRON ACCEPTORS



## ATTACHMENT C

### NATURAL ATTENUATION PARAMETERS FOR CHLORINATED VOLATILE ORGANIC COMPOUND PLUMES SCREENING PROCESS SUMMARY FOR REDUCTIVE (ANAEROBIC) DECHLORINATION

Potential Electron Donors	Electron Acceptors:	Reduced Species:	Related Dechlorination Pathway:
Native total organic carbon (TOC)	Dissolved Oxygen	⇒ Carbon Dioxide (CO <sub>2</sub> )	~ DCE → VC → CO <sub>2</sub>
Anthropogenic carbon (e.g., leachate)	Manganese (Mn <sup>4+</sup> )	⇒ Manganese (Mn <sup>2+</sup> )	~ DCE → VC
Fuel hydrocarbons (e.g., BTEX)	Nitrate (NO <sub>3</sub> )	⇒ Nitrite (NO <sub>2</sub> )	~ DCE → VC
Lightly chlorinated solvents (DCE/VC)	Ferric Iron (Fe <sup>3+</sup> )	⇒ Ferrous Iron (Fe <sup>2+</sup> )	~ DCE → VC → CO <sub>2</sub>
	Sulfate (SO <sub>4</sub> )	⇒ Sulfide (S <sup>2-</sup> , HS <sup>-</sup> , H <sub>2</sub> S)	~ TCE → DCE → VC → Ethene
	Carbon Dioxide (CO <sub>2</sub> )	⇒ Methane (CH <sub>4</sub> )	~ PCE → TCE → DCE → VC → Ethene

#### Geochemical Parameter List:

Parameter	Field or Lab	Rationale	Importance
Volatile organic compounds	L	Source products; daughter products; electron donors (e.g., benzene, toluene, ethylbenzene, and xylene; BTEX)	1
Dissolved oxygen	F	Primary electron acceptor (respiration); an/aerobic indicator	1
Nitrate (and nitrite), dissolved	F or L	Anaerobic electron acceptor (product of nitrate reduction)	1
Manganese, dissolved	F or L	Anaerobic electron acceptor	1
Ferrous Iron (Fe <sup>2+</sup> )	F	Product of iron reduction	1
Sulfate [and sulfide (S <sup>2-</sup> )]	F or L	Common anaerobic electron acceptor (product of sulfate reduction)	1
Sulfide (H <sub>2</sub> S)	F	Common product of sulfate reduction	1
Methane, ethane, ethene	L	Product of methanogenesis; daughter products of reductive dechlorination	1
Chloride	L	Ultimate daughter product of reductive dechlorination	1
TOC - upgradient groundwater	L	Electron donor	1
ORP, pH, specific conductance, temperature, turbidity	F	General water quality determination	1
Carbon dioxide (CO <sub>2</sub> )	F	Anaerobic electron acceptor (methanogenesis); biotic respiration indicator	2
Alkalinity/DIC	F	Buffering capacity; biotic respiration indicator	2
Hydrogen, dissolved	L	Fingerprint for characterizing electron acceptor pathway - indicator of what redox is occurring	2
TOC - upgradient soil	L	Input to analytical NA models; quantifies soil-water distribution coefficient and retardation factor	2
Volatile fatty acids	L	Determination of anthropogenic carbon used as an electron donor	3

Importance: 1=Most important; 3=Least important (depending on DQOs, all may be recommended).  
See Attachment E for details regarding analytical methods.

## ATTACHMENT D

### NATURAL ATTENUATION PARAMETERS FOR PETROLEUM HYDROCARBON PLUMES SCREENING PROCESS SUMMARY FOR OXIDATIVE (AEROBIC) DEGRADATION

Parameter	Field or Lab	Rationale	Importance
Volatile organic compounds	L	Source products; daughter products; electron donors (BTEX)	1
Dissolved oxygen	F	Primary electron acceptor (respiration); an/aerobic indicator	1
Nitrate (and nitrite), dissolved	F or L	Anaerobic electron acceptor (and product of nitrate reduction)	1
Manganese, dissolved	F or L	Anaerobic electron acceptor	1
Ferrous Iron ( $\text{Fe}^{2+}$ )	F	Product of iron reduction	1
Sulfate [and Sulfide ( $\text{S}^{-2}$ )]	F or L	Common anaerobic electron acceptor (product of sulfate reduction)	1
Sulfide ( $\text{H}_2\text{S}$ )	F	Common product of sulfate reduction	1
TOC - upgradient groundwater	L	Electron donor	1
ORP, pH, specific conductance temperature, turbidity	F	General water quality determination	1
Dissolved methane ( $\text{CH}_4$ )	L	Product of methanogenesis	1
Anions: chloride ( $\text{Cl}$ ), nitrate ( $\text{NO}_3$ ), nitrite ( $\text{NO}_2$ ), phosphate ( $\text{PO}_4$ ), sulfate ( $\text{SO}_4$ )	L		1
TOC - Upgradient soil	L	Input to analytical NA models; quantifies soil-water distribution coefficient and retardation factor	2
Biological oxygen demand (BOD)	L	Understanding of aquifer oxygen demand	3
Chemical oxygen demand (COD)	L	Understanding of aquifer oxygen demand	3

Importance: 1=Most important; 3=Least important (depending on DQOs, all may be recommended).



**ATTACHMENT E**  
**GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUMES, CONTAINERS,**  
**PRESERVATION, HOLDING TIMES, AND DETECTION RANGES**  
**PAGE 1 OF 4**

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Alkalinity	CHEMetrics K-9810, K-9815, K-9820 -ASTM D 1067-92 -EPA 310.1	Titret® Titration Ampules / Hydrochloric Acid, Phenolphthalein	Field. Follow test kit instructions. Avoid agitation and analyze at well head to determine total alkalinity. Filter if turbid (>10 NTU).	10-100 (K-9810) 50-500 (K-9815) 100-1000 (K-9820)	N/A	10 50 100-
Alkalinity	Fixed-base lab -EPA 310.1	N/A	100 to 250 mL in glass or plastic container. Cool to 4°C. Analyze within 14 days. Filter if turbid.	N/A	N/A	N/A
Alkalinity / Dissolved Inorganic Carbon	HACH AL-DT -HACH 8203 -SM 2320 / SM 403	Digital Titration / Hydrochloric Acid, Phenolphthalein (P) and Total (M)	Field. Follow test kit instructions. Avoid agitation and analyze at well head to determine carbonate, bicarbonate, and hydroxide ions. Filter if turbid as recommended by manufacture. May use a pH meter for colored samples.	10-4000	N/A	10
Arsenic	Fixed-base lab -SW-6010 B	N/A	1 liter glass or polyethylene container. HNO <sub>3</sub> to pH ≤ 2. 6 months.	N/A	N/A	N/A
Biochemical Oxygen Demand	Fixed-base lab -EPA 410.1	N/A	2 liter HDPE. Cool to 4°C. Analyze within 48 hours.	N/A	N/A	N/A
Carbon Dioxide, dissolved	CHEMetrics K-1910, K-1920, K-1925 -ASTM D 513.82 -SM 4500-CO <sub>2</sub> -C	Titret® Titration Ampules / Sodium Hydroxide, Phenolphthalein	Field. Follow test kit instructions. Avoid agitation and analyze at well head.	10-100 (K-1910) 100-1000 (K-1920) 250-2500 (K-1925)	N/A	10 100 250
Carbon Dioxide, dissolved	Fixed-base lab -VOA water sample (Vaportech)	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Carbon Dioxide, dissolved	Fixed-base lab -Microseeps gas stripping cell	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Carbon Dioxide, dissolved	HACH CA-DT -HACH 8205 -Mod. SM 406	Digital Titration / Sodium Hydroxide, Phenolphthalein	Field. Follow test kit instructions. Do not aerate or agitate. Analyze at well head.	10-1000	N/A	10
Chemical Oxygen Demand	Fixed-base lab -EPA 410.1	N/A	125 mL HDPE. H <sub>2</sub> SO <sub>4</sub> to pH <2.0. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Chloride (Cl)	Fixed-base lab -EPA 300	N/A	100 to 250 mL in glass or plastic container. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Chlorine - Total (Cl <sub>2</sub> )	HACH DR-850 -HACH 8167 -SM 4500-Cl	Colorimeter / DPD Method	Field. Follow test kit instructions.	0.02-2.00	± 0.01 mg/L with a 1.00 mg/L chlorine solution.	1
Conductance, Specific	Field Meter -SW-9050 A	Direct Reading Meter	100 to 250 mL in glass or plastic container. Analyze immediately.	N/A	N/A	N/A
Ethane, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Ethane, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A

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# ATTACHMENT E

## GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER, PRESERVATION, HOLDING TIME, AND DETECTION RANGES PAGE 2 OF 4

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Ethene, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Ethene, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Fraction Organic Carbon (foc)-Soil Upgradient Saturated Soil	Fixed-base lab -Walk-Black -SVW-846 9060	N/A	200 gram glass jar. Cool to 4°C. Analyze within 14 days.	N/A	N/A	N/A
Hydrogen, dissolved	Fixed-base lab -Microseeps or Vapor Tech gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial.	N/A	N/A	N/A
Iron, ferrous (Fe <sup>2+</sup> )	HACH DR-850 -HACH 8146 -Mod. SM 315 B	Colorimeter 1, 10 Phenanthroline	Field. Follow test kit instructions. Analyze immediately at well head. Filter if turbid (>10 NTU) as recommended by the manufacture.	0-3.00	+0.017 mg/L with a 2.00 mg/L Fe <sup>2+</sup> solution.	0.03
Iron, ferrous (Fe <sup>2+</sup> )	HACH IR-18C -Mod. SM 315 B	Color Disc 1, 10 Phenanthroline	Field. Follow test kit instructions. Analyze immediately at well head. Filter if turbid (>10 NTU) as recommended by the manufacture.	0-10	N/A	0.2
Iron, total dissolved (Filtered)	Fixed-base lab -SVW-846 6010B	N/A	250 mL in plastic container. Field filter to 0.45 µ. HCl to pH <2. Cool to 4°C. Analyze within 6 months.	N/A	N/A	N/A
Manganese (Mn <sup>2+</sup> )	HACH DR-850 -HACH 8034 -CFR 44(116) 34193	Colorimeter / Cold Periodate Oxidation	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-20.0	+ 0.18 mg/L with a 10.00 mg/L Mn solution.	0.12
Manganese (Mn <sup>2+</sup> )	HACH MN-5 -Mod. SM 319 B -CFR 44(116) 34193	Color Disc / Cold Periodate Oxidation	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-3	N/A	0.1
Manganese, total dissolved (Filtered)	Fixed-base lab -SVW-846 6010B	N/A	250 mL in plastic container. Field filter to 0.45 µ. HCl to pH <2. Cool to 4°C. Analyze within 6 months.	N/A	N/A	N/A
Methane, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Methane, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Nitrate (NO <sub>3</sub> <sup>-</sup> )	Fixed-base lab -EPA 300	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours.	N/A	N/A	N/A
Nitrate (NO <sub>3</sub> <sup>-</sup> )	HACH DR-850 -HACH 8192 -Mod. EPA 353.2	Colorimeter / Cadmium Reduction	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Pretreatment required if nitrite is present.	0-0.50	+ 0.03 mg/L with a 0.25 mg/L of nitrate nitrogen (NO <sub>3</sub> <sup>-</sup> N) solution.	0.01
Nitrite (NO <sub>2</sub> <sup>-</sup> )	Fixed-base lab -EPA 300	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A

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ATTACHMENT E

GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER,  
PRESERVATION, HOLDING TIME, AND DETECTION RANGES  
PAGE 3 OF 4

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Nitrite (NO <sub>2</sub> <sup>-</sup> )	HACH DR-850 -HACH 8507 -Mod. EPA 354.1 -Mod. SM 419 -CFR 44(85) 25595	Colorimeter / Diazotization	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-0.350	± 0.001 mg/L with a 0.250 mg/L nitrite nitrogen solution.	0.005
Nitrogen, dissolved	Fixed-base lab -Microseeps gas stripping cell -Vaportech VOA water sample	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required for Microseeps. Ship in glass septum vial (Microseeps) or VOA vial (Vaportech).	N/A	N/A	N/A
Nitrogen, Total Kjeldahl	Fixed-base lab -EPA 351.2	N/A	500 mL plastic/glass container. Cool to 4°C. H <sub>2</sub> SO <sub>4</sub> to pH ≤ 2. Analyze within 28 days.	N/A	N/A	N/A
Oxidation Reduction Potential	Field Meter -ASTM D-1498	Direct Reading Meter	Field. Do not aerate. Gently agitate probe using flow over or flow-through method. Analyze immediately at well head.	N/A	N/A	N/A
Oxygen, dissolved	CHEMetrics K-7501, K-7512 -ASTM D 5543-94 -ASTM D 887-92	CHEMetrics® Vacuum Vials / Rhodazine D and Indigo Carmine	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-1 (K-7501) 1-12 (K-7512)	N/A	0.025 1
Oxygen, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Oxygen, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Oxygen, dissolved	HACH OX-DT -HACH 8215 -SM 4500-O-G	Digital Titration / Azide Modification of Winkler Digital Titration Method	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	1-10	N/A	1
Oxygen, dissolved	HACH DR-850 (AccuVac Ampules) LR HRDO Method	-Indigo Carmine Method -Rhodazine D Method	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-0.8 ppm 0-10 ppm	0.01 ppm 0.1 ppm	N/A
Oxygen, dissolved	Field Meter	Direct Reading Meter	Analyze immediately at well head. Avoid agitation and analyze immediately at well head. Used for well stabilization measurement parameter only.	N/A	N/A	N/A
pH	Field Meter -SW 9040B	Direct Reading Meter	Analyze immediately at well head.	N/A	N/A	N/A
Phosphate (ortho)	Fixed-base lab -EPA 300	Ion Chromatography	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Phosphate, potassium	Fixed-base lab -SW-846 8010B	Inductively Coupled Plasma	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Salinity	Field Meter	Direct Reading Meter	Analyze immediately.	N/A	N/A	N/A
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	Fixed-base lab	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Sulfate (SO <sub>4</sub> <sup>2-</sup> )	HACH DR-850 -HACH 8051 -EPA 375.4	Colorimeter / Turbimetric SulfaVer 4	Field. Follow test kit instructions. Filter if turbid as recommended by the manufacture.	0-70	± 0.5 mg/L with a 50 mg/L sulfate solution.	4.0
Sulfide (Hydrogen Sulfide, H <sub>2</sub> S)	HACH HS-C -HACH Proprietary -Mod. SM 426 C	Color Chart / Effervescence of H <sub>2</sub> S through sulfide reactive paper	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-5	N/A	0.1
Sulfide (S <sup>2-</sup> )	CHEMetrics K-9510 -SM 4500-S <sup>2-</sup>	CHEMetrics® Vacuum Vials / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-1 1-10	N/A	0.1 1

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ATTACHMENT E

GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER,  
 PRESERVATION, HOLDING TIME, AND DETECTION RANGES  
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Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Sulfide ( $S^{2-}$ )	Fixed-base lab - EPA 376.1/376.2	N/A	1 liter in plastic container, no headspace. NaOH to pH >9. Cool to 4°C. Avoid agitation and analyze within 7 days.	N/A	N/A	N/A
Sulfide ( $S^{2-}$ )	HACH DR-850 - HACH 8131 - SM 4500-S <sup>2</sup>	Colorimeter / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head. Pretreatment required for turbid samples as recommended by the manufacture.	0-0.70	± 0.02 mg/L with a 0.73 mg/L sulfide solution	0.01
Sulfide ( $S^{2-}$ )	HACH HS-WR - SM 4500-S <sup>2</sup>	Color Disc / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head. Pretreatment required for turbid samples as recommended by the manufacture.	0-11.25	N/A	0.1-2.5
Temperature	Field Meter / Thermometer - E 170.1	Direct Reading Meter / Thermometer	Analyze immediately.	N/A	N/A	N/A
Total Organic Carbon (TOC)-Groundwater	Fixed-base lab - E 415.1	N/A	125 mL HDPE. H <sub>2</sub> SO <sub>4</sub> to pH < 2.0. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Turbidity	Field Meter - E 180.1	Direct Reading Meter	Analyze immediately.	N/A	N/A	N/A

N/A = Not applicable.



## **APPENDIX VII**

### **HEALTH AND SAFETY PLAN**

**Health and Safety Plan  
for  
Remedial Investigation &  
Risk Assessment  
at  
Site 22 Building 105 Old Dry Cleaning  
Facility**

**Naval Training Center  
Great Lakes  
Great Lakes, Illinois**



**Southern Division  
Naval Facilities Engineering Command**

**Contract No. N62467-94-D-0888  
Contract Task Order 0154/0290**

July 2001  
Revised July 2002  
Revised April 2003

**HEALTH AND SAFETY PLAN  
for  
REMEDIAL INVESTIGATION &  
RISK ASSESSMENT  
at  
SITE 22 – BUILDING 105 OLD DRY CLEANING FACILITY  
  
NAVAL TRAINING CENTER GREAT LAKES  
GREAT LAKES, ILLINOIS**

**COMPREHENSIVE LONG-TERM  
ENVIRONMENTAL ACTION-NAVY (CLEAN) CONTRACT**

**Submitted to:  
Southern Division  
Naval Facilities Engineering Command  
2155 Eagle Drive  
North Charleston, South Carolina 29406**

**Submitted by:  
Tetra Tech NUS, Inc.  
661 Andersen Drive  
Pittsburgh, Pennsylvania 15220**

**CONTRACT NUMBER N62467-94-D-0888  
CONTRACT TASK ORDER 0154/0290**

**JULY 2001  
Revised July 2002  
Revised April 2003**

**PREPARED UNDER THE  
SUPERVISION OF:**

**APPROVED FOR SUBMITTAL BY:**

---

**ROBERT DAVIS, P.E.  
TASK ORDER MANAGER  
TETRA TECH NUS, INC.  
PITTSBURGH, PENNSYLVANIA**

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CLEAN HEALTH & SAFETY MANAGER  
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## 1.0 INTRODUCTION

This Health and Safety Plan (HASP) is an addendum to the existing HASP (Appendix VII and VIII) in the existing Quality Assurance Project Plan (QAPP) (TtNUS, 2001) for Naval Training Center (NTC) Great Lakes and encompasses the activities that are to be conducted at Site 22 - Building 105 Old Dry Cleaning Facility during the Remedial Investigation/Risk Assessment. The investigation at Site 22 will be similar to the investigation at Site 7. Changes to the existing HASP will be noted in the text below for the Site 22 - Building 105, Old Dry Cleaning Facility investigation. Tetra Tech NUS, Inc. (TtNUS) will conduct these activities under the Comprehensive Long-Term Environmental Action, Navy (CLEAN) Contract Number N62467-94-D-0888, in accordance with the Statement of Work for Contract Task Order (CTO) 290 at the NTC Great Lakes.

Site activities to be conducted at NTC Great Lakes, Site 22 include the following (see Section 4.0 for a detailed description):

- Mobilization/demobilization
- Monitoring well installation/construction. Methods that may be employed include:
  - Direct-push technology
  - Hollow-stem auger
- Multi-media sampling including:
  - Surface soil
  - Subsurface soil (during well installation)
  - Groundwater
- Equipment decontamination
- Aquifer testing – Slug testing
- Groundwater level measurements
- Investigation-derived waste handling and disposal
- Site restoration
- Land surveying of sample locations

## 1.2 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

**Site Name:** NTC Great Lakes **Address:** EFA Midwest  
 Building 1A, Code N457  
 201 Decatur Avenue  
 Great Lakes, IL 60088

**NTC Great Lakes Point of Contact:** Mr. Dan Fleming or Mr. Mark Schultz

**Phone Number:** Dan - (847) 688-5999 x 161 **E-Mail:** flemingdm@EFDSOUTH.NAVFAC.NAVY.mil

**Phone Number:** Mark - (847) 688-5999 x 140 **E-Mail:** schultzmr@pwcgl.navfac.navy.mil

**Fax Number:** (847) 688-2319

**U.S. Navy Remedial Project Manager/Engineer-In-Charge:** Anthony Robinson (Code 18511)

**Address:** 2155 Eagle Drive  
 North Charleston, South Carolina 29406 **Phone Number:** (843) 820-7339  
**Fax Number:** (843) 820-7465  
**E-mail Address:** robinsonab@efdsouth.navfac.navy.mil

**Base Pass and Security:** Building 130 (near Main Gate); Hours of Operation 0600 – 1800

**Phone Number:** (847) 688-5648

Note: See Section 9.5.1 for Base Access Information.

**Purpose of Site Visit:** This activity is divided into a multi-task operation (see Section 4.0) including Direct-push technology [DPT] soil borings, monitoring well and piezometer installation, and multi-media sampling, and other related activities.

**Proposed Dates of Work:** July 2003 until September 2003

### Project Team:

<b>Tetra Tech NUS Personnel:</b>	<b>Discipline/Tasks Assigned:</b>	<b>Phone No.</b>
<u>Robert Davis, P.E.</u>	<u>Task Order Manager</u>	<u>(412) 921-7251 davisb@ttnus.com</u>
<u>Aaron Bernhardt</u>	<u>Assistant Task Order Manager/Ecological</u>	<u>(412) 921-8433 bernhardta@ttnus.com</u>
<u>Matthew M. Soltis, CIH, CSP</u>	<u>CLEAN Health and Safety Manager</u>	<u>(412) 921-8912 soltism@ttnus.com</u>
<u>Thomas M. Dickson, CSP</u>	<u>Project Health and Safety Officer</u>	<u>(412) 921-8457 dicksont@ttnus.com</u>
<u>Bob Balkovec</u>	<u>Project Geologist/Field Operations Leader (FOL)</u>	<u>(412) 921-8616 balkovecb@ttnus.com</u>
<u>Tom Patton</u>	<u>Equipment Manager</u>	<u>(412) 859-4670</u>



## 2.0 EMERGENCY ACTION PLAN

### 2.3.1 Drilling Activities

**Struck By** – In 2001, a person from Tetra Tech Inc. experienced an injury when a high-pressure line released from its connection and struck the person in the head. This injury could possibly have been prevented by following these recommendations:

Inspect equipment arriving on site. Pay particular attention to the guarding apparatus surrounding high-pressure lines, especially those that separate the lines and nearby operators. For those high-pressure lines without physical barriers/guards between the operator and the lines, insure that these lines have cable links to prevent the lines from becoming separated from their connections.

### 2.5.2 Life Threatening

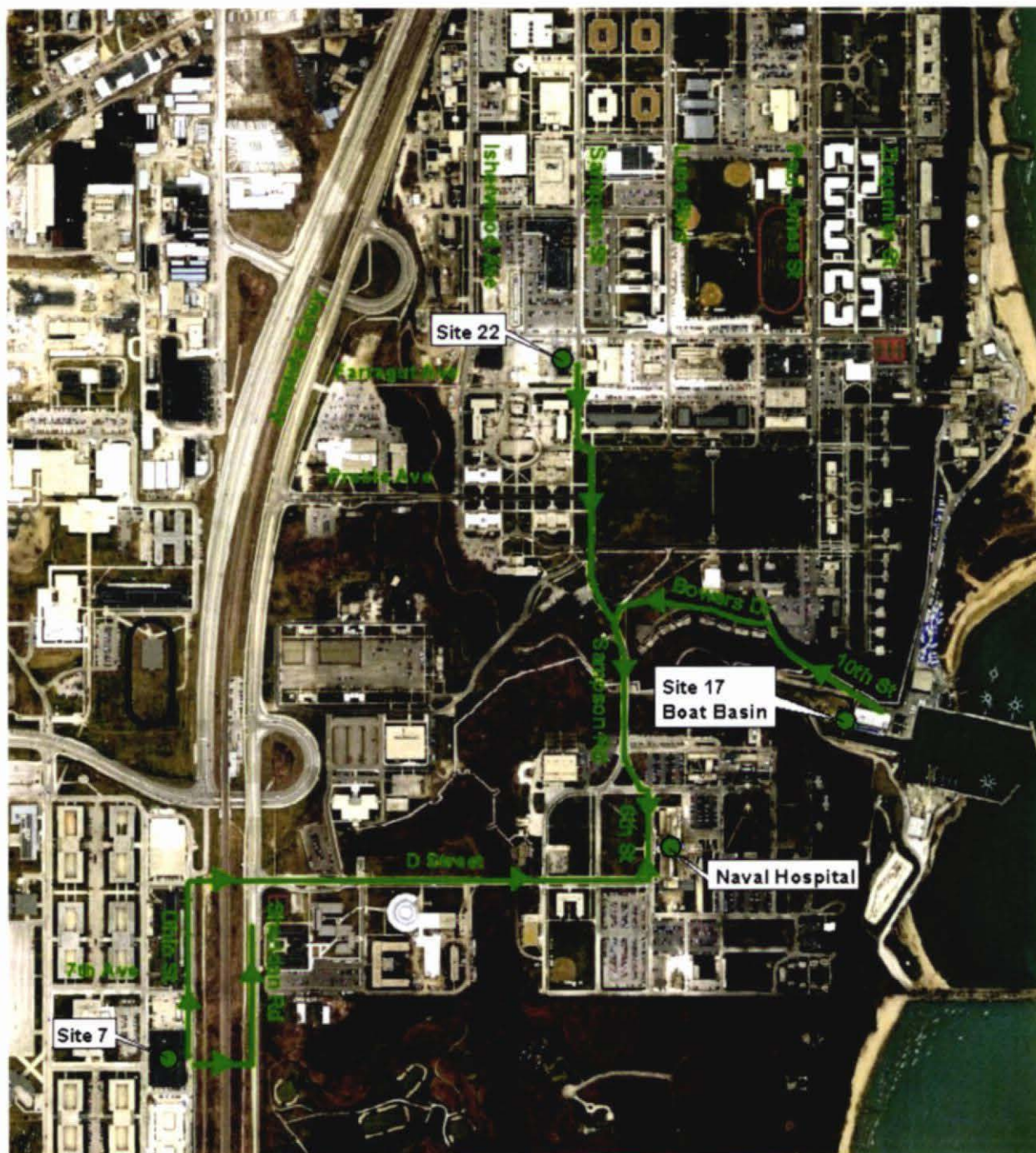
- Have one person notify off-site response agencies and engage Emergency Notification Sequence
- If it will not endanger the injured individual (i.e., spinal cord injury, etc.) remove any outer personnel protective equipment (PPE). Removal may require the use of bandage scissors to remove the outer garments.
- Begin life-saving techniques as appropriate (CPR, cooling or warming regimens, etc.).
- Wrap the injured person in a blanket for transport to the hospital.
- Follow instructions provided in Figure 2-1.

**TABLE 2-1**  
**EMERGENCY CONTACTS**  
**NTC GREAT LAKES**

<b>AGENCY</b>	<b>TELEPHONE</b>
EMERGENCY (Police, Fire, and Ambulance Services)	911*
Non-Emergency (Police, Fire, and Ambulance Services)	(847) 688-3430
U.S. Navy Remedial Project Manager/Engineer-in-Charge – Mr. Anthony Robinson	(843) 820-7339
U.S. Navy/NTC Great Lakes Point of Contact – Mr. Dan Fleming	(847) 688-5999 Ext. 161
Great Lakes Naval Hospital (Primary)	911 (Primary) (847) 688-4560 Duty Officer (847) 688-5555 Ambulance (847) 688-5618 Emergency
TtNUS Task Order Manager - Robert Davis	(412) 921-7251
CLEAN Health and Safety Manager – Matthew M. Soltis	(412) 921-8912
Project Health and Safety Officer - Tom Dickson	(412) 921-8457
WorkCare (TtNUS Healthcare Provider)	1-800-455-6155 Ext. 109 Fax (714) 456-2154
Utility Location (15 Working Days Advance Notification Required) Ms. Judy Jarosz (Primary) Mr. Chuck Kelly (Back-up)	(847) 688-2121 Ext. 18 (847) 688-2121 Ext. 10
Utility Emergency – Public Works Dept. – NTC Great Lakes (Monday – Friday 0700 – 1630) Trouble Desk (Holidays and Saturday/Sundays)	(847) 688-3849 (847) 688-4820

\* - Cellular communications will be routed through Lake County Dispatch. It is imperative that you inform them that you are calling from the NTC Great Lakes facility. 911 will work from any Base extension.

## 2.8 ROUTE TO HOSPITALS



### 3.0 SITE BACKGROUND AND DESCRIPTION

#### 3.1.3 Site 22 - Building 105 Old Dry Cleaning Facility

Building 105 is located at the NTC Great Lakes in Lake County, Illinois. NTC Great Lakes (EPA # IL7170024577) has operated with Resource Conservation and Recovery Act (RCRA) interim status authorization since November 19, 1980. Building 105 was originally included in a RCRA Part A permit that has been modified over the past 25 years.

Building 105 was constructed in 1939 and was utilized as a dry cleaning facility until 1993 or 1994 when it was converted to a vending machine supply and repair station. The RCRA unit consisted of a slab-on-grade building measuring approximately 150 feet by 70 feet. The 10,500-square foot building occupied a lot approximately 250 feet by 115 feet. Building 105 was actively used to warehouse and repair vending equipment and vending products until February 2001. The building was demolished in March 2003.

Soil and groundwater sampling has taken place at Building 105 as documented in the Partial Closure Certification and Sampling/Inspection Report (PCC&SIR). The contaminants of concern and maximum detected concentrations in the soil and groundwater are as follows:

Contaminant of Concern	Maximum Concentration Recorded
Tetrachloroethene (PCE)	600 mg/kg (soil); 7,400 ug/l (groundwater)
cis-1,2-Dichloroethene (DCE)	850 ug/kg ; 1,300 ug/L

The "hot spot" is apparently located on the southern and eastern sides of the building along Sampson Street. The extent of the PCE and DCE plume will be further defined when permanent groundwater wells are installed around Site 22 as part of this investigation.



For emergency care only, non-Navy personnel are permitted to go to the Navy Hospital:

Great Lakes Naval Hospital  
3001A Sixth Street  
Great Lakes, Illinois 60088-2833  
(Sheridan Road and South Gate Entrance)

(847) 688-4560 Duty Officer  
(847) 688-5555 Ambulance  
(847) 688-5618 Emergency

From Site 22 - Building 105 – Former Dry Cleaning Facility

1. Exit Site 22 Turn Right onto Sampson Street (South).
2. The hospital is on the left
3. Follow signs to the appropriate entrance to the hospital (3001A Sixth Street).

Task/Operation/ Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment (Items in <i>italics</i> are deemed optional as conditions of the FOL or SSO dictate.)	Decontamination Procedures
<p>Hollow Stem Auger and Direct Push Drilling Operations including:</p> <ul style="list-style-type: none"><li>- Soil borings</li><li>- Monitoring Well Installations</li><li>- Piezometer Installations</li></ul> <p>DPT - This activity employs hydraulic pressure and percussion hammer to advance tooling into the ground.</p> <p>This activity is planned for the following locations:</p> <ul style="list-style-type: none"><li>- Soil borings – 6 at Site 7</li><li>- Monitoring Well Installations – 5 to be installed at Site 7</li><li>- Piezometer Installations – 3 of the 6 soil borings at Site 7 will be converted to piezometers</li></ul> <p>This activity will also include the well and piezometer abandonment activity.</p> <p>Bldg.105</p> <p>Eleven soil borings and eleven monitoring wells to be installed.</p>	<p><b>Chemical hazards:</b></p> <p>1) Previous analytical data available for the work areas did not identify contaminants in sufficient concentrations to establish occupational exposure threat. General categories of site contaminants include:</p> <ul style="list-style-type: none"><li>- PAHs</li><li>- Metals</li><li>- Pesticides/PCBs</li></ul> <p>Bldg. 105</p> <ul style="list-style-type: none"><li>- PCE</li><li>- DCE</li></ul> <p>Further information on these categories of contaminants are provided in Section 6.1.</p> <p>2) Transfer of contamination into clean areas or onto persons</p> <p><b>Physical hazards:</b></p> <p>3) Heavy equipment hazards (pinch/compressions points, rotating equipment, hydraulic lines, etc.)</p> <p>4) Noise in excess of 85 dBA</p> <p>5) Energized systems (contact with underground or overhead utilities)</p> <p>6) Lifting (strain/muscle pulls)</p> <p>7) Slips, trips, and falls</p> <p>8) Cuts and lacerations</p> <p>9) Vehicular and foot traffic</p> <p>Further information on these physical hazards, see Section 6.2 for further discussions.</p> <p><b>Natural hazards:</b></p> <p>10) Inclement weather</p>	<p><b>Chemical hazards:</b></p> <p>1) Safe work practices will be employed as the first line of defense. As a general rule, avoiding contact with contaminated media (air, water, soils, etc.) will be employed as a universal control measure.</p> <p><b>Particulates/Liquids with an Elevated Boiling Temperature</b> -As some of the materials in question are solids ( Site 7 i.e., naphthalenic distillates (PAHs), metals, pesticides/PCBs) and/or bound to particulates, the next control measure to be employed to minimize potential exposure will be good work and personal hygiene practices. These control measures including avoiding hand-to-mouth contact to the extent possible, washing hands and face or using hygienic wipes to remove potential contaminants from hands and face prior to breaks or lunch or other hand to mouth activities will restrict the most predominant route of exposure. Dust suppression methods including area wetting will be employed to control mechanically generated dust emissions.</p> <p><b>Liquids/gases</b> – In situations where contaminants exist in soils or liquid media and presents a vapor or gas hazard threat as is the case with Bldg. 105, real time monitoring instruments and PPE will be employed to support protective measures. As part of the evaluation method, all samples will be scanned with a PID to determined potential source concentrations.</p> <p>2) <b>Transfer of Contamination into Clean Areas or onto Persons</b> - Restrict the cross use of equipment and supplies between locations and activities without first going through a suitable decontamination. Work practices including:</p> <ul style="list-style-type: none"><li>- A rigid decontamination procedure will be employed for all equipment between locations and between clean and potentially dirty work. This provision along with dedicated sampling equipment will insure materials are not carried and deposited in unaffected areas.</li></ul> <p><b>Physical hazards:</b></p> <p>3) <b>Heavy Equipment Hazards</b> - All equipment will be:</p> <ul style="list-style-type: none"><li>- Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600.601.602), and manufacturer's design, as applicable. All inspections will be documented using the Equipment Inspection Checklist found in (See Attachment III) of this HASP.</li><li>- Operated and supported by certified operators and knowledgeable ground crew.</li><li>- Used within safe work zones, with routes of approach clearly demarcated. All personnel not directly supporting this operation will remain at least 25 feet from the point of operation. See Section 9.0 of this HASP. This will be the area identified as the exclusion zone.</li><li>- All self-propelled equipment shall be equipped with movement warning systems.</li><li>- All personnel will be instructed in the location and operations of the emergency shut-off device(s). This device will be tested initially (and then periodically) to ensure its operational status.</li><li>- Areas will be inspected prior to the movement of the direct push rig and support vehicles to eliminate any physical hazards. This will be the responsibility of the FOL and/or SSO.</li><li>- The direct push, drill rigs, and support vehicles will be moved no closer than 5-feet to unsupported side-walls of excavations and embankments.</li><li>- See additional safe work procedures for drilling in Section 5.2 of this HASP.</li></ul> <p>4) <b>Noise in Excess of 85 dBA</b> - Hearing protection will be used during all subsurface activities using the HAS drill and direct push rig or when noise levels are &gt;85 dBA. (during operation). Previous accumulated data indicates an average 8 hour exposure working behind a direct push rig during hydraulic and hammer advancement of the tooling is approximately 90-102 dBA. The HSA Drill rig averaged 89-96dBA. Controlling this hazard shall be accomplished employing two separate approaches as follows:</p> <ul style="list-style-type: none"><li>- Boundaries will be established to limit the affect of the noise hazard. Typically, the height of the mast + 5 feet or a minimum of 25 feet is normal for DPT rigs, and the height of the mast plus 5-feet is suitable for the HSA Drill Rig.</li><li>- Hearing protection – As a general rule of thumb, hearing protection will be employed when</li></ul> <p><i>Excessive noise levels (&gt;80dBA) are being approach when you have to raise your voice to talk to someone within 2 feet of your location.</i></p> <p>5) <b>Energized Systems</b> - All drilling activities will proceed in accordance with the Utility Locating and Excavation Clearance SOP in Attachment II of this HASP. All utility clearances will be obtained, in writing, and locations identified and marked, prior to activities. If it is not obtainable/unknown or the location infringes within 3-feet of an underground utility advancement must proceed by hand until past the utility. The hand dug hole should represent the same diameter of the mechanized tooling that will enter the subsurface media.</p> <p>6) <b>Lifting Hazards</b> - Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques as described in mobilization/demobilization, Table 5-1.</p> <p>7) <b>Slips, Trips, and Falls</b> - Preview work locations for unstable/uneven terrain.</p> <ul style="list-style-type: none"><li>- Cover, guard and barricade all open pits, ditches, and floor opening as necessary.</li><li>- Ruts, roots, tools, and other tripping hazards should be eliminated approaching points of operation to minimize trips and falls when approaching operating equipment.</li><li>- Maintain a clutter free work area.</li><li>- As part of site control efforts construct fences or other means of demarcation (i.e. signs and postings) to control and isolate traffic in the work area. Means of demarcation shall also be constructed isolating resource and/or staging areas.</li></ul> <p>8) <b>Cuts and Lacerations</b> - To prevent cuts and lacerations associated with extracting samples from the acetate liners of the Macro-Core Sampling System , the following provisions are required:</p> <ul style="list-style-type: none"><li>- Obtain and use the knife and acetate tube retention tub recommended by Geoprobe to prevent accidents of this nature. These items have been engineered to allow sample acquisition without putting the sampler at risk.</li><li>- Always cut away from yourself and others, then, if a knife slips, you will not impale yourself or others.</li><li>- Do not place items to be cut in your hand or on your knee.</li><li>- Change out blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments.</li></ul> <p>9) <b>Vehicular and Foot Traffic Hazards</b> - Use traffic-warning signs, flag persons, and high visibility vests as determined by the SSO when working along traffic thoroughfares. In addition, use physical barricades, when working within normal traffic flow patterns/traffic lanes.</p> <p><b>Natural hazards:</b></p> <p>10) <b>Inclement Weather</b> – To minimize hazards of this type, the following provisions shall be employed:</p> <ul style="list-style-type: none"><li>- Wear appropriate clothing for weather conditions.</li><li>- Provide acceptable shelter and replacement liquids for field crews as relief from excessive ambient temperatures.</li><li>- Under conditions of elevated levels of PPE, periods of acclimatization, excessive ambient temperature extremes, or if you believe someone is suffering from a heat/cold related disorder, it may be necessary to conduct heat/cold stress monitoring.</li><li>- Electrical storms/high winds - Suspend or terminate operations until directed otherwise by SSO.</li></ul> <p>Follow the provisions as specified in Section 4.0 of the Tetra Tech NUS, Inc. Health and Safety Guidance Manual regarding the identification and evaluation of heat/cold stress related conditions.</p>	<p>1) Monitoring shall be conducted to as a general screening effort to qualify and quantify estimated source concentrations of site contaminants in support of the prescribed worker protection levels.</p> <p>Monitoring shall be conducted using a Photoionization Detector (PID) with 10.6eV lamp strength.</p> <p><b>Site 7</b></p> <ul style="list-style-type: none"><li>- 10 ppm in the workers breathing zone for no greater than 10 minutes duration, no more than 4 occurrences in a single day. Action levels of this level will protect personnel from achieving the most conservative TLV/TWA.</li><li>- Dusts/particulates – All dust/particulate concentrations will be maintained to below visual recognition which is estimated at 2 mg/m<sup>3</sup>.</li></ul> <p><b>Bldg. 105</b></p> <ul style="list-style-type: none"><li>- 10 ppm in the workers breathing zone.</li><li>- Dusts/particulates – All dust/particulate concentrations will be maintained to below visual recognition which is estimated at 2 mg/m<sup>3</sup>.</li></ul> <p>Concentration in excess of these action levels require personnel to stop work and notify PHSO.</p> <p>Monitoring shall be conducted at the prescribed depths as indicated on the boring logs at the source (borehole) and drillers breathing zone. Monitoring shall also be conducted at the samplers location in the same prescribed frequency when handling samples.</p> <p>Noise monitoring will be conducted at the discretion of the PHSO and/or the SSO.</p> <p>Action Level - &gt;85 dBA Participation in the Project Hearing Conservation Program. Hearing protection is required for this operation.</p> <p>Noise level measurements of greater than 105dBA will require the use of combination plugs and muff for noise protection.</p> <p>All sound level measurements and noise dosimetry should proceed in accordance with the project Hearing Conservation Program(See Attachment VI).</p>	<p>All soil boring and monitoring well installation operations will be initiated in Level D protection, including the following articles:</p> <p><b>Sampler/Oversight Personnel</b></p> <ul style="list-style-type: none"><li>- Standard field dress (long pants, Sleeved shirts)</li><li>- Steel toe safety shoes or work boots</li><li>- Hard hat(when within the established site control boundaries of the drill or direct push rig or when sampling)</li><li>- Safety Glasses(when within the established site control boundaries of the drill or direct push rig or when sampling)</li><li>- Nitrile surgeon style inner gloves for sampling</li><li>- Hearing protection(when within established boundaries of an operating direct push and/or drill rig)</li><li>- <i>Impermeable boot covers</i></li><li>- <i>Reflective vest for traffic areas</i></li></ul> <p><b>Driller and Driller Helper</b></p> <ul style="list-style-type: none"><li>- Standard field attire including sleeved shirt and long pants</li><li>- Safety shoes (Steel toe/shank)</li><li>- Safety glasses</li><li>- Nitrile inner and outer gloves or equivalent protection</li><li>- Hearing protection</li><li>- Hard hat</li><li>- Impermeable aprons are recommended for handling MacroCore Samplers and auger flights to prevent soiling work clothes</li><li>- <i>Impermeable boot covers</i></li></ul> <p>As site conditions may change, the following equipment will be maintained during all on-site activities</p> <ul style="list-style-type: none"><li>- Fire Extinguishers</li><li>- First-aid Kit</li><li>- Portable Eyewash. This is required during well/piezometer abandonment due to the caustic nature of the Portland Cement.</li></ul> <p><b>Note:</b> The Safe Work Permit(s) for this task (See Attachment IV of this HASP) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.</p>	<p><b>Personnel Decontamination</b> will consist of a soap/water wash and rinse for reusable and non-reusable outer protective equipment (boots, gloves, impermeable apron, as applicable</p> <p>Gross contamination of outer boots and outer gloves will be removed at a satellite location near the operation. Final wash and rinse will take place at the centralized decontamination pad. The sequential procedure is as follows:</p> <p>Stage 1: Remove visible materials from hand tools, wash with soap and water.</p> <p>Stage 2: Soap/water wash and rinse of outer boots (as necessary) and gloves</p> <p>Stage 3: Soap/water wash and rinse of the impermeable apron, as applicable.</p> <p>Stage 4: Disposable PPE will be removed and bagged.</p> <p>Stage 5: Wash face and hands</p> <p><b>Note:</b> For remote locations away from the centralized decontamination unit</p> <ul style="list-style-type: none"><li>- Bag and/or wrap all disposable and reusable equipment, respectively for transport back to the decontamination unit.</li><li>- Hygienic wipes may be used for cleaning hands and face</li></ul> <p><b>Equipment Decontamination</b> - All heavy and sampling equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner or pressure washer as prescribed in Table 5-1 for that task. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. All site vehicles will have restricted access to exclusion zones. Vehicles will have their wheels/tires cleaned or sprayed off as applicable as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity.</p> <p>The FOL or the SSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation.</p>

Task/Operation/ Location	Anticipated Hazards	Recommended Control Measures	Hazard Monitoring - Type and Action Levels	Personal Protective Equipment (Items in <i>italics&gt; are deemed optional as conditions or the FOL or SSO dictate.)</i>	Decontamination Procedures
<p>Multi-media sampling, including</p> <ul style="list-style-type: none"> <li>- Surface water – direct pour or pump</li> <li>- Ground water – Peristaltic/bladder pumps</li> <li>- Surface soils and sediments – Trowel</li> <li>- Subsurface soils – hand auger, soil corers, and mechanized support (See Soil boring Table 5-1).</li> <li>- IDW – Trowel, soil corer, or pump.</li> </ul> <p>Protective measures as recommended here shall also apply to aquifer development and hydraulic conductivity testing.</p>	<p><b>Chemical hazards:</b></p> <p>1) Site 7 Previous analytical data available for the work areas did not identify contaminants in sufficient concentrations to establish a significant occupational threat. General categories include</p> <ul style="list-style-type: none"> <li>- PAHs</li> <li>- Metals</li> <li>- Pesticides/PCBs</li> </ul> <p>Bldg. 105</p> <ul style="list-style-type: none"> <li>- PCE</li> <li>- DCE</li> </ul> <p>Further information on these categories of contaminants are provided in Section 6.1.</p> <p>2) Transfer of contamination into clean areas.</p> <p><b>Physical hazards:</b></p> <p>3) Slip, trip, and fall hazards</p> <p>4) Strain/muscle pulls from manual lifting</p> <p>5) Cuts and Lacerations</p> <p>6) Ambient temperature extremes (heat/cold stress)</p> <p>7) Site Characterization</p> <p><b>Natural hazards:</b></p> <p>8) Animal and insect bites and encounters</p> <p>9) Inclement weather</p> <p>10) Water/Mud Bog hazards</p>	<p><b>Chemical hazards:</b></p> <p>1) Many of the contaminants as associated with Site 7 have not been thoroughly identified as this site is going through its initial investigation as it pertains to certain media. Safe work practices will be employed as the first line of defense. As a general rule, avoiding contact with contaminated media (air, water, soils, etc.) will be employed as a universal control measure. <b>Particulates/Liquids with a Elevated Boiling Temperature</b> -As some of the materials in question are solids (i.e., naphthalenic distillates (PAHs), metals, pesticides/PCBs) and/or bound to particulates, the next control measure to be employed to minimize potential exposure will be good work and personal hygiene practices. These control measures including avoiding hand-to-mouth contact to the extent possible, washing hands and face or using hygienic wipes to remove potential contaminants from hands and face prior to breaks or lunch or other hand to mouth activities will restrict the most predominant route of exposure. Dust suppression methods including area wetting will be employed to control mechanically generated dust emissions. <b>Liquids/gases</b> – In situations where contaminants exist in soils or liquid media and present a vapor or gas hazard threat such is the case with Bldg. 105 contaminants, real time monitoring instruments and PPE will be employed to support protective measures. As part of the evaluation method of these subsurface media, all samples will be scanned with a PID to determined potential source concentration.</p> <p>2) <b>Transfer of Contamination into Clean Areas</b> - Decontaminate all equipment and supplies between sampling locations and prior to leaving the site. See decontamination of heavy and sampling equipment for direction in this task.</p> <p>3) <b>Slip, Trip, and Fall Hazards</b> – These hazards shall be minimized by adherence to the practices listed below. This includes</p> <ul style="list-style-type: none"> <li>- Maintain proper housekeeping in all work areas.</li> <li>- Preview and inspect work areas to identify and eliminate slip, trip, or fall hazards.</li> <li>- Cover, guard, barricade, and or place warning postings over/at holes or openings that personnel may fall or step into.</li> <li>- For traversing steep, slippery, or sloped terrain establish rope ladders to control ascent and descent to sampling areas or use alternative pathways.</li> <li>- Regular Ladders should be placed to allow access and egress from steep embankment and levy walls when collecting samples along Pettibone Creek and the Boat Basin.</li> <li>- Use multiple persons and pack small loads to remote locations.</li> </ul> <p>4) <b>Strain/Muscle Pulls from Manual Lifting</b> - Use machinery or multiple personnel for heavy lifts. Use proper lifting techniques (See Lifting Mobilization/Demobilization, Page 1 of 6, Table 5-1).</p> <p>5) <b>Cuts and Lacerations</b> – Employ the following measures to reduce and/or eliminate the potential for cuts and lacerations</p> <ul style="list-style-type: none"> <li>- Obtain and use the knife and acetate tube retention tub recommended by Geoprobe to prevent potential cuts and lacerations when accessing samples within MacroCore and Dual Tube Sampling System acetate liners. These items have been engineered to allow sample acquisition without putting the sampler at risk.</li> <li>- Select and secure the most favorable route to monitoring wells and sampling locations.</li> <li>- Previewing pathways - Where possible, remove or demarcate the physical hazards.</li> <li>- Inspect all cutting equipment to be used to clear access routes for defects.</li> <li>- When cutting items - always use a sharp knife and always cut away from your body. Do not place items to be cut in your opposite hand or on your knee.</li> <li>- Carry all glassware and items that present a potential for cuts, lacerations, or impalement such as machetes or brush hooks in protective packaging or sheathed to avoid breakage or exposure in the event of a slip, trip, and/or fall.</li> </ul> <p>6) <b>Ambient Temperature Extremes (Heat/Cold Stress)</b> - Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding heat/cold stress is provided in Section 4.0 of the Health and Safety Guidance Manual.</p> <p>7) <b>Site Characterization</b> - Work areas will be surveyed prior to committing personnel or resources. The survey will be conducted by the FOL and/or the SSO. The purpose is to identify physical and natural hazards that may impact the proposed work area. These hazards are to be identified, barricaded, or eliminated to the extent possible to minimize potential effect to field crew.</p> <p>8) <b>Animal and Insect Bites and Encounters</b> - To combat the potential impact of natural hazards, the following actions are recommended:</p> <ul style="list-style-type: none"> <li>- Avoid nesting – Preview routes, avoid nests, if at all possible.</li> <li>- Wear light color clothes. This will allow easier detection of ticks and insects crawling on your body. It will also assist in heat stress control.</li> <li>- Tape pant legs to work boots to block direct access.</li> <li>- Use repellents – Permanone should be applied liberally to the clothing, but not the skin as it may cause irritation. Concentrate on areas where ticks and other insects may access your body such as pant cuffs, shirt to pants, and collars.</li> <li>- Upon exiting the high brush and wooded areas perform a close body inspection to remove any ticks or other insects that have attached to your clothing or skin.</li> <li>- If working in snake infested areas personnel are directed to adhere to the following provisions: <ul style="list-style-type: none"> <li>a. Leave snakes and animals alone, do not harass or try to capture. Contact the SSO for direction in the removal of animals and snakes within the confines of the work site.</li> <li>b. Snake chaps or high leather boots should be worn in unimproved or unmaintained areas on an initial sweep of the area, if you are unknowledgeable regarding nesting and habitat considerations for indigenous animals and reptiles.</li> <li>c. Keep hands and feet out of areas you cannot see. Exercise extreme care when lifting materials or debris providing ground cover as snakes and other animals prefer these areas to nest.</li> <li>d. Be cautious when moving debris or other structures, that may serve as a nest. Do not use your hands to separate debris piles. Use equipment (hand tools or heavy equipment, as available).</li> </ul> </li> <li>- As this activity may take personnel into areas of heavier vegetation, samplers should be cognizant of poison ivy, poison oak, and poison sumac in the area. See Section 6.3.3 for descriptions of these plants. Protective measures to be used to minimize hazards of this nature <ul style="list-style-type: none"> <li>a) Avoid direct contact through the use of Tyvek coveralls, clothing, or barrier creams</li> <li>b) Wash after contact with cool water and mild soap.</li> <li>c) Wash equipment contaminated with the oils of these plants to avoid cross contamination.</li> </ul> </li> </ul> <p>9) Suspend or terminate operations during electrical storms. Return to work when directed by the FOL and/or the SSO.</p> <p>10) <b>Water/Mud Hazards</b> – As part of site preparation, sample locations along Pettibone Creek and the Boat Basin will require marking, mapping, and removal/barricading of physical hazards, as well as, securing access. This will bring persons along the water ways, areas of soft footing and mud. To minimize these obvious hazards</p> <ul style="list-style-type: none"> <li>- On a Boat - All personnel shall wear Type III personal flotation devices in the event someone falls overboard, boats sinks or capsizes. Type IIIs were selected as they offer the most flexibility for working while still meeting minimum requirements for bouyancy. In situations where personal flotation devices cannot be worn due to the task to be conducted, Type IV Throwable flotation devices shall be immediately available/accessible.</li> <li>- Near Waters Edge -When work activities take personnel within four feet of navigable waters edge and over soft footing (Mud/bog areas) personnel will have immediately accessible a lifeline with a throwing bag or Type IV flotation device facilitate extraction from the water or mud. All personnel working on waters edge and bog areas will do so using the buddy system to assist in rescue efforts, if needed. Where necessary work platforms can be laid down to provide a larger surface area of support in muddy/bog areas.</li> </ul>	<p>1) Monitoring shall be conducted to as a general screening effort to qualify and quantify estimated source concentrations of site contaminants in support of the prescribed worker protection levels.</p> <p>Monitoring shall be conducted using a Photoionization Detector (PID) with 10.6eV lamp strength.</p> <p><b>Site 7</b></p> <ul style="list-style-type: none"> <li>- 10 ppm in the workers breathing zone for no greater than 10 minutes duration, no more than 4 occurrences in a single day. Action levels of this level will protect personnel from achieving the most conservative TLV/TWA.</li> <li>- Dusts/particulates – All dust/particulate concentrations will be maintained to below visual recognition which is estimated at 2 mg/m<sup>3</sup></li> </ul> <p><b>Bldg. 105</b></p> <ul style="list-style-type: none"> <li>- 10 ppm in the workers breathing zone.</li> <li>- Dusts/particulates – All dust/particulate concentrations will be maintained to below visual recognition which is estimated at 2 mg/m<sup>3</sup></li> </ul> <p>Concentration in excess of this action level require personnel to stop work, notify PHSO.</p> <p>Monitoring shall be conducted at the prescribed depths as indicated on the boring logs at the source (borehole) and drillers breathing zone. Monitoring shall also be conducted at the samplers location to in the same prescribed frequency when handling samples.</p>	<p>Level D protection will be utilized for the following sampling activities</p> <p>Surface water, groundwater, and sediments</p> <p>Sampler/Oversight Personnel</p> <ul style="list-style-type: none"> <li>- Standard field dress (long pants, Sleeved shirts)</li> <li>- Steel toe safety shoes or work boots</li> <li>- Safety Glasses</li> <li>- Nitrile surgeon style inner gloves for sampling</li> <li>- <i>Impermeable boot covers</i></li> <li>- <i>Reflective vest for traffic areas</i></li> <li>- <i>Identified flotation devices</i></li> </ul> <p>Protective Measures as specified for drilling and soil boring will be employed for all subsurface soil sampling.</p> <p><b>Upgrades to Level C protection are not anticipated.</b></p> <p><b>Note:</b> The Safe Work Permit(s) for this task (See Attachment IV) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task, additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.</p>	<p><b>Personnel Decontamination</b></p> <p>Sampling surface water, groundwater, and sediments, the following provisions will apply (Remote Locations)</p> <ul style="list-style-type: none"> <li>- Upon completion of the sampling dedicated trowels, tubing, etc. will be bagged for transport back to the central decontamination area.</li> <li>- PPE (gloves) will be removed and also bagged for disposal.</li> <li>- Handi-Wipes or similar product will be used to clean hands, prior to moving to the next location.</li> </ul> <p><b>Equipment Decontamination</b></p> <p>All equipment used in remote sampling locations will be brought back to the central decontamination area for decontamination and re-use or disposal.</p> <p>Decontamination of equipment (sampling and hand tools) will proceed as indicated in the Work Plan and/or the QAPP.</p>

## 6.0 HAZARD ASSESSMENT

### 6.1 CHEMICAL HAZARDS

Contaminants of concern at Site 22 - Building 105 Old Dry Cleaning Facility are chlorinated hydrocarbons including PCE and DCE

Analytical data from previous site investigations indicates that contaminant concentrations are capable of presenting an occupational exposure concern via inhalation. Typical toxicological responses associated with inhalation include central nervous system effects of sleepiness, clumsiness, possible headaches, and, in extreme cases, hallucinations and stupor.

Typical toxicological response associated with contact includes irritation at all points of contact if there are sufficient concentrations. Systemically, exposure through these routes may result in nausea, vomiting, weakness, tremors, and cramps. Chronic exposures may result in dermatitis and liver and/or kidney damage. It is anticipated that the greatest potential for exposure to site contaminants is during intrusive activities (drilling, soil sampling, etc.). Exposure to these compounds is most likely to occur through ingestion of contaminated soil or water via hand-to-mouth contact. For this reason, PPE and basic hygiene practices (washing face and hands before leaving site) will be extremely important. Inhalation exposure will be avoided by using appropriate PPE and engineering controls where necessary. Significant exposure via inhalation is not anticipated during the planned scope of work.

## 7.0 HAZARD MONITORING

The contamination at Site 22 includes PCE and DCE as the primary contaminants of concern. Typical responses to these substances by real-time monitoring equipment such as a photoionization detector (PID) with a 10.6 eV lamp strength are 70 percent or greater; these substances are readily detected.